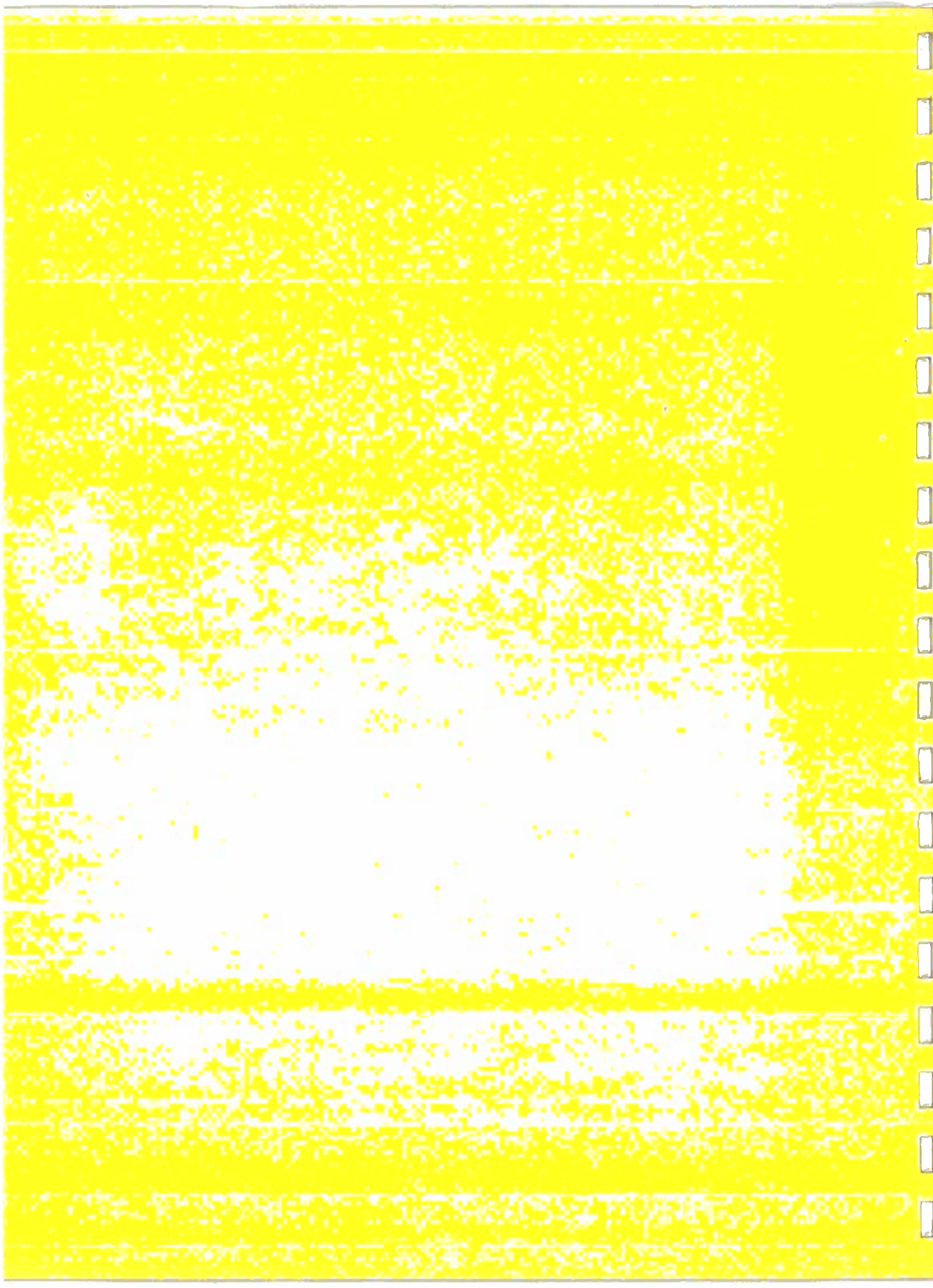


ALUSTRALIA —

DOWN UNDER &
"OFF" TO ONE SIDE.

KATHERINE ^{and} ALLAN

Dec. 28, 1958



CHAPTER I
DEPARTURE

On the 28th. day of December, 1958, my wife Katherine and I, set off on the second great adventure of our lives. The first began 31 years before when we started on a honeymoon trip that took us through Owens Valley, California, the Westgard pass into the high snow-covered deserts of Nevada, Death Valley, and finally the Grand Canyon of Arizona and home to Carlsbad, California.

Now we were being driven through a dense fog to the Los Angeles International Airport by our daughter Lucia and her husband Marvin Sippel, to enplane for Hawaii, the first stop on a journey to the Fiji Islands and the down under lands, Australia and New Zealand.

Between the usual snatches of "going away" conversation, my thoughts kept returning to that first great departure day and on the intervening years with a mixture of awe and nostalgia; it came to me that everyone's life is probably a record of chance decisions made, roads taken, which if not taken would have produced an entirely different chain of events. I thought of that day in 1944 when I had chanced to read two articles that changed the course of my life. This was the day on which had been born for me, the compelling idea of "cosmic collision"---the concept that the collision of large meteorites with the earth had played a major role in the geological history of our planet. Had I not on that day chanced to read two seemingly unrelated articles, "When the Comet Struck"¹ and "Our Search for the Earliest Americans"², I would not now be preparing to embark on a 7,000-mile journey to the other side of the world.

We arrived at the airport and the fog boiling thickly around the car preceding us into the parking lot, brought me back to the present: How could any pilot see to land or take off in this "soup"? Radar, we decided, was the miracle which allowed planes to come and go regardless of sleet or fog, but when we reached the airline counter we found that even radar had its limitations and that our flight had been delayed. Finally, by 11:15 a.m., visibility had improved to the extent that we were allowed to take off. Mrs. Kelly and I ^{Bade} bid our daughter and son-in-law goodby, and with their confident "bon-voyage" and good wishes ringing in our ears we found ourselves at last on our way to Honolulu and those other romantic place names of the wide Pacific.

Once we had risen above the fog the day took on a brighter aspect, but, while I was able to relax physically, my mind kept returning to thoughts of past events, those chance circumstances, and the anticipation of what was to come. Would the land down under provide the evidence to support cosmic collision? Would that photograph packed away in my suit case turn out to be a real meteor crater? For 14 years I had been seeking out such evidence,---reading everything available, pouring over maps and traveling over western America in search of collision evidence. The evidence already accumulated had resulted in one published book called 'TARGET: EARTH, which I co-authored with Dr. Frank Dacheille in 1952, and, an ever-increasing appetite on my part for ~~facts~~ more and more facts, which would prove to a reluctant world ^{the importance the importance of} of geology ~~that~~ meteoritic collision ~~is truly a thing to be reckoned with.~~ *in the history of the earth.*

The two articles mentioned above which had first brought the insight of this rather awesome concept, appeared in different publications, but somehow, formed the link between the subject with which they were concerned. How this happens, no one can tell. We only know that man cannot will to have such insight. The first article by Malton and Schriever, Geologists from the University of Oklahoma, advanced the theory that

thousands upon thousands of meteorites (a comet's head) had struck the earth along the Carolina Coast, blasting out the depressions now seen there as oval lakes along the coastal plain. The second article by Dr. Frank Hibben of the University of New Mexico, told of the search for artifacts and other evidence of early man among the frozen remains of mammoth, saber toothed tiger and other extinct animals of the Pleistocene era which had been found frozen in a muck of gravel, mud, tree trunks, and other debris along the Yukon River in Alaska. Although Dr. Hibben did not venture to say what the cause of this concentration of frozen mammals might have been, his suggestion that they must have been overtaken by some sudden cataclysm, immediately suggested to me the link with the Carolina Bays and the possibility that these latter depressions might be only the fringe scars along the Carolina Coast and that a much larger crater made by the comet lay in the ocean off the coast where the main body might have stuck. Such a major collision, I reasoned, might have moved the axis of the earth so that these animals of a temperate climate were moved into arctic regions and drowned by the icy waters of the arctic ocean, so that they froze immediately and remained so thereafter.

Investigation of this lead proved fruitful. I found that there was indeed, off the Carolina Coast, a great under-sea, crater-like basin with a curving wall nearly a thousand miles long and averaging more than 15,000 feet high, a mountain wall as rugged and steep as the wall of the Grand Canyon and three times as high.

Other evidences of catastrophic collision were readily apparent in nearly every area where I looked for them. I had been, therefore, greatly intrigued by the Pacific Islands and all of the lands down under from all my readings of them. Then, in 1957, an article appeared in SKY & TELESCOPE (July issue, page 429) describing a feature in Western Australia which was suspected of being a meteorite crater. The photograph

which accompanied the article raised an exciting possibility to me: The small crater which was being described and which had been visited by Dr. P. S. Hossfeld of the University of Adelaide, appeared to be in the center of a much larger depression, perhaps five miles across, and encircled by a high rim, the whole feature resembling the overlapping craters which occur on the moon. I immediately began to investigate this possibility through correspondence with Dr. Hossfeld and eventually obtained a large Australian Air Force photograph of the area which only served to increase my excitement.

Consequently when my friend of many years, Dr. H. H. Nininger, world-famous meteorite sleuth (Meteoriticist, in technical language) invited me to join him and Mrs. Nininger in Australia which was to be the final leg of a seven-month tour of the Pacific and the Orient, I found it impossible to resist.

It had taken a bit of doing, but finally our plans had crystallized and Mrs. Kelly agreed to accompany me on a tour of Hawaii, Fiji, New Zealand, and eastern Australia. She would return home from Adelaide and I would then fly to Perth to join the Niningers on a land tour of the sites of various known meteorite craters and a close-up look at the suspected crater in the inland desert of the Australian continent.

Through such an accumulation of ideas and events did Mrs. Kelly and I now find ourselves 17,000 feet above the Pacific ocean enroute to the island paradise of Hawaii. I could hope that whatever our experiences down under might be, they would result in the idea of cosmic collision being considered a little less "off to one side."

1. "When the Comet Struck"--Saturday Evening Post, September 11, 1944
2. "Our Search for the Earliest Americans"--Sept. 1944, page 13

CHAPTER II

H A W A I I

When we arrived in Honolulu at 5:30 p.m. we discovered that our reservations at the Edgewater Hotel had been transferred to the Breakers Hotel because of a delayed sailing of a Matson liner, leaving 750 passengers staying over in the various Honolulu hotels. The Breakers was very nice, as it turned out. The rooms were all on the ground floor and had individual patios with banana trees and flowers growing against a high wall.

After dinner and a walk along the main street in Waikiki, we returned to our hotel and retired to the sound of the surf and the gentle tropic breezes blowing through the coco palms--or was it the sound of sport car exhausts, screaming and giggling girls, the raucous yells and jeers of their escorts, of younger fry shooting firecrackers and torpedos in the street nearby? At any rate, it began to rain about midnight and the Hollywood sounds abated. We dozed off to the sound of wind in the coco palms and rain dripping from the leaves in our banana garden.

December 29, 1958:

After an early breakfast we took a bus tour around the island of Oahu. In preparation for our first stop at a Buddhist temple, our bus driver (who said he was a mixture of seven different races) told the story about the English boy and Chinese boy attending respective funerals at the same time in the same cemetery. The Chinese served a nine-course dinner on top of the grave; the Englishman covered the

grave with flowers. "English boy say, 'When your dead man coming out to eat the nine-course dinner?' China boy say, 'Same time your dead man come out to smell flowers.'"

Continuing up a canyon beyond the city, the bus took us past many fine homes in the rain forest jungle. The driver said that land there sold by the square foot, about \$1.25 in that location, but that down on the beach at Waikiki, it was \$18.00 to \$20.00 per square foot.

We stopped to look down off the cliffs where the early Hawaiians had had some of their fiercest battles, throwing each other over the cliff. The road then led down a steep grade to the northwest shore of the island and a town called Kaneohe, and thence along the coast through many small villages to Laie Bay where we stopped to buy green palm-leaf hats with flowers and a bird stuck on the top. Mrs. Kelly would not unbend to wear one but I bought one; I gave it away later in the day to a school teacher who was leaving next day for the States. Mrs. Kelly didn't think I looked healthy in it anyway.

We stopped for lunch--a very special Hawaiiin fish dinner--at a place called Lion's Head Tavern and then continued our jtour through the sugarcane and pineapple plantations near the center of the island, returning to Honolulu by way of Pearl Harbor.

In the evening we treated ourselves to a real Japanese meal with chopsticks and all the trimmings. Some stateside tourists with their Japanese-American friends ate in regulation Japanese style, sitting cross-legged on the floor at little tables 10 inches high. One rather heavy woman was in extreme misery, but her husband seemed to enjoy it--her misery and the meal too. The food was cooked in a little brasier right on the table and I do believe it was the best we had on the whole trip.

December 30, 1958:

We took the short tour around Honolulu in a big Cadillac Limousine with two school teachers and an elderly farm woman from Texas. We were driven through the best residential section of Honolulu where flowers and gardens were beyond description, and then visited the famous Punch Bowl military cemetery where Ernie Pyle is buried. His is just a simple grave like all the rest. No eulogy, no written word; Only a small granite slab with his name, among all the other names. Thousands of Americans and many from foreign lands visit this grave each year. Its simplicity does great honor to a very brave man.

We were served a very fine lucheon at the Salvation Army Tea Room which is surrounded by an acre or two of tropical gardens. Robert Louis Stevenson's original grass shack is located at one end of these lovely gardens.

In the afternoon we went down to the Health Department in Honolulu where Mrs. Kelly finally got her birth certificate and a legal first and middle name. She was born on the island of Maui. With this done we could travel to foreign lands.

Our schedule didn't allow us time to visit the large island of Hawaii, but on my return home some two months later I rented a car and made the 243-mile trip around the island. Hawaii is a mighty volcanic island rising more than 30,000 feet above the floor of the Pacific ocean. South from the town of Kona and around the island to the east the road threads its way among the lava flows at an elevation of about 1,200 feet. There are wayside stores and villages every few miles through this region which is a coffee-growing area. Holes are dug in the lava, a hatful of soil is thrown into the hole, and a coffee tree is planted. The lava soil is so porous that it holds water like a sponge and the rainfall is

such that nothing lacks for water. Nothing to do but pick the coffee berries and lie in the shade until dusk. Then comes ukulele time and songs of the islands!

Each big lava flow along the Kona road is marked with a road sign giving the name of the flow and the date when it occurred. The dates of these flows go back to the early settlement of the islands. They all look quite fresh and frothy with little sign of decomposition, but they do show a definite difference in age by the amount of lichen, moss, ferns, and larger plant growth which has accumulated since the flow cooled. All of these flows are exceedingly rough and hummocky with sharp and jagged surfaces.

The two great volcanoes, Mauna Loa and Mauna Kea, in Hawaii National Park, are nearly the same height, being 13,680 and 13,784 feet above sea level, respectively. Mauna Kea is no longer active but Mauna Loa is very much alive, having averaged one large eruption and lava flow every 16.6 years for the last 150 years. Mauna Loa is nearly 40 miles wide across its sea level base and forms an almost perfect arch against the sky at whatever point around the island one may chance to view it. This perfect dome shape is unusual because we tend to think of volcanoes as sharp peaks like Fiji. Its cause is the fluidity of the lava which is so hot it does not cool quickly.

→
Distance of
some
no good!

Kilauea Crater on the east flank of Mauna Loa was long the most active volcano in the world, being in continuous eruption for over 100 years. However, in 1947 it slowed down and came to a stop and remained inactive since, except for numerous steam vents which show that molten lava must not be far below.

784
182
104

Halemaumau Crater, called the first pit, has not erupted since 1954, the longest stretch of inactivity on records, But on November

14, 1959, the near-by Kilauea Iki Crater blew its top and erupted in a fiery fountain. In a few days it was breaking all records for molten lava fountains, red-hot lava having been thrown to heights of over 1,900 feet above the crater floor.

On the northwest side of the island, not far from ⁱKilauea[?] Crater, there is an area of what appears to be old lava that had been scoured clean of all surface decomposed rock. It is hummock in formation with mounds and basins and troughs between the hummocks, with small, or rather scrub, trees scattered over it. The elevation of this section is about 3,500 feet above sea level.

The island of Oahu has five low volcanic craters at the southeast end of the island, the highest being Diamond Head, which is only 760 feet above sea level. The two main mountain ranges on the island, the Koolau and the Waianae, are between 3,000 and 4,000 feet high and are without sign of crater or fissure flow. The many steep pali (nearly vertical cliffs) along the northeast side of the Koolau range have a very peculiar fluted or columnar effect which I have not seen elsewhere. Shallow depressions in the face of the cliff, appearing to be perhaps 100 to 200 feet wide and 10 to 20 feet in depth, extend from top to bottom of the cliffs--a sort of giant corrugation standing on edge. The other side of the Koolau range is only an average mountain slope. Similar pali are found on the island of Maui, but they are not so high. Most of them are found along the walls of deep canyons which cut down from the relatively flat top of the island.

One can't help asking: How did lava flow in such a way to form cliffs 400 to 500 feet high? Or, how could erosion produce them? If the island of Oahu had been built up from the bottom of the ocean by volcanoes, then they should remain the highest part of the island.

2
vicinity of
Noli
Light etc.

If the long ridge of lava is from fissure flow, why doesn't it show the individual flows and why should the range be vertical cliffs on one side and gentle slopes on the other? These are questions the orthodox geologist has failed to answer.

At 7:15 p.m. we took off for the Fiji Islands by Pan American Clipper. The Nadi (pronounced Nandi) airport on the big island of Viti Levu in Fiji is over 3,300 miles down under, just about as far south of the equator as Honolulu is north of it. No formal ceremonies were held upon crossing the line because it was about one o'clock in the morning, but Pan American promised to send everyone certificates.

It was bright moonlight and I stayed awake most of the night watching the marvelous cloud formations; giant cumulus clouds towering far above us with dark recesses and chasms and, now and then, openings to the moonlit sea thousands of feet below; a billowy fairyland stretching away to infinity with an occasional flash of lightning from deep within some far-off giant. This awe-inspiring sight was not lessened by the thought that 17,000 feet below lay 17,000 feet of ocean water, arctic cold at the bottom and warm on top, while in our comfortable cabin we could look out on the red-hot exhaust stacks of those big motors working in Arctic cold. How wonderful the works of man, in half the span of a single lifetime! I recalled that poetic passage in the Psalm of David: "Though I take the wings of the morning, and dwell in the uttermost parts of the sea; even there shall Thy hand lead me, and Thy right hand shall hold me...."--up, I hoped.

All the other passengers were asleep, or were giving a reasonable imitation of being so. I wondered how many were really asleep and how many were thinking about that deep ocean below. And again I wondered--how many aboard that plane really appreciated the very marvelous mechanism which was carrying them across the sea, or ever gave a thought to the dreamers of 50 years ago who had made it possible. To borrow from Winston Churchill, "Rarely have so many been so greatly indebted to so few."



CHAPTER III

F I J I

The geology of Fiji is something like that of Hawaii, but the Fijiian islands are arranged in a circular pattern rather than in a chain as are those of Hawaii. The whole group of several hundred islands is scattered over a circle some 330 miles in diameter. Predominant are two large islands--Viti Levu, about 100 miles in diameter and nearly round, and Vanua Levu, about 120 miles long and 25 miles wide--and two smaller islands with high mountains of similar size and kind as those on the two big islands. All the other islands are comparatively small and low.

A map of Fiji reveals an almost complete lack of volcanic craters in and on a high mountain plateau rising out of the deep surrounding sea. Only two small crater islands, and one large caldera located on the island of Ovalau, appear on the map. Yet all this vast pile of material is lava. How did it build up off the deep sea floor without more visible craters remaining?

January 1, 1959:

Our plane arrived over the outer Fijian islands at about 4:30 a.m. and rolled down the airstrip at Nadi soon after. We were greatly surprised at the dry, yellow grassy hills; we had expected tropical green.

In the customs office the first person we met was a very black bushy-haired Fijian in military coat and white skirt. His very correct Oxford English and pleasant smile reassured us and we

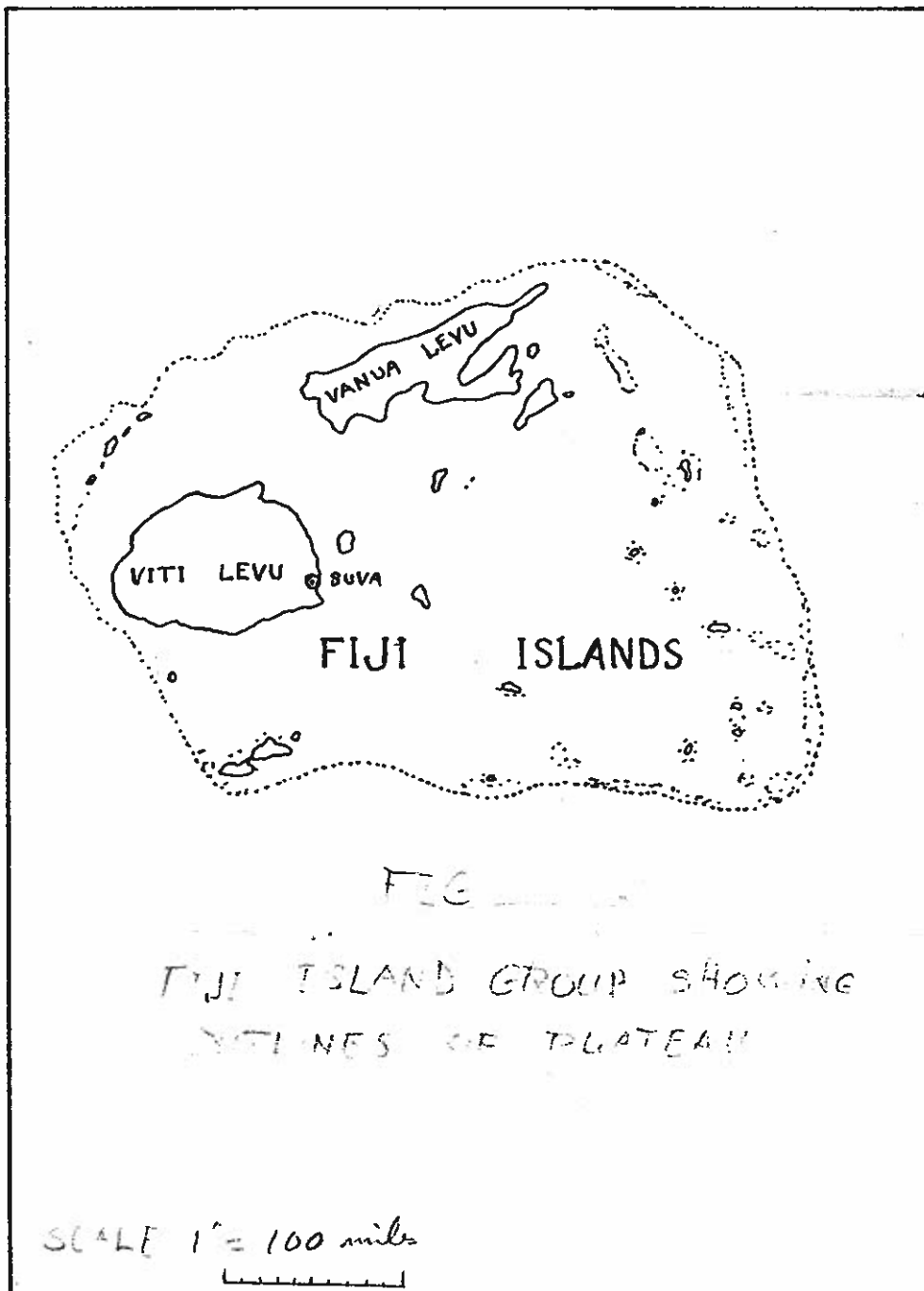


FIG. 1

FIJI ISLAND GROUP SHOWING
PLATEAUS

SCALE 1" = 100 miles



were directed through customs in a very few minutes.

At 7:30 a.m., after a 75¢ breakfast for which we paid \$2.80 because of our ignorance of the Fijian pound, we boarded the bus for Suva with 11 Hindus, some tourists from Australia, and a young man from Anchorage, Alaska. More Hindus, mostly women and children, got on the bus at the town of Nadi, which is about five miles from the airport.

Something over one-half (166,000) of the population of Fiji is East Indian. Fijians make up the bigger part of the other half (147,000), while about 9,000 are Europeans.

It soon became obvious that everyone is supposed to get out of the way of a bus. The driver never slowed down for anything except large animals; people scattered in all directions grabbing up the smaller fry as they went. Traffic drives on the left side of the road in Fiji and for the first few hours I was sure we were going to hit every passing car or truck--and it does take real skill to miss them because the road is so narrow and winding. It is 142 miles from Nadi to Suva and it takes the better part of a day to make the trip. There is only a short stretch of pavement at each end, the rest of the road is gravel.

Around Nadi the main crop is sugarcane. Most of the land is rolling and some of it is quite mountainous. The mountains themselves are nearly bare having been burned over many times by escaping sugarcane fires which are lighted to burn the dry leaves off the sugarcane before harvesting. The hills are bare of grass, I should say, for grass grows six feet tall and very thick.

As the road progresses around the island toward Suva the vegetation gradually thickens until on the southeast side it becomes real

jungle with many kinds of vines growing in the trees and with palms and giant tree ferns growing so densely it is impossible to see more than a few feet into the growth. Along the south coast the mountains come right down to the sea and each canyon forms a little delta at its mouth with a white sand beach perhaps a quarter of a mile to a half-mile wide and a deep channel cut through the coral reef to the sea. In practically every one of these places the Fijians have built a little village, with rows of thatched-roof houses, neatly trimmed lawns, and coco-palms growing everywhere. Coconuts, fish, and a few taro-patches along the creek are all that they need for the perfect existence, although a little fighting and feasting on the flesh of their enemies now and then relieved the monotony in the old days. We counted 32 of these villages between Nadi and Suva, some consisting of only a half-dozen houses.

The Indians live in the big river valleys where they engage in agriculture of various types. Sugarcane, tapioca, and rice are the main crops, but many vegetables and grains are also grown. Most of the plowing is still done by oxen--not the zebu but the old-type Spanish or European cattle. There are many horses in Fiji, too, mostly owned by the Fijians who use them to ride and race on Sundays.

*picture of
open
yes!*

During most of our journey around the south coast of the island the weather was beautiful with a cool breeze blowing off the ocean, but as we neared Suva it began to rain. Suva is the capital city of Fiji and has a population of 75,000. The Grand Pacific Hotel where we stayed is considered the best in Suva. It was built about 1900 when the British Empire was at its peak and when British capital really did things on a grand scale. It stands on a rectangular site about two or three acres in area built out into the Bay. Just across

the main street are the cricket grounds--about 20 acres all in lawn-- and on either side of them, Government buildings, the museum, and the governor's palace. The hotel itself is not large, having only two stories, but the whole center of the building opens to a large glass roof and the wide verandas extend around both the ground and upper floor. It was built for cross ventilation in all directions and is certainly quite cool. There is no beach and no swimming pool on the grounds; only a seawall with dirty water at high tide and wide mudflats at low tide.

The bay and harbor at Suva are very uninteresting because the reef which encloses the harbor is far off shore (about three miles) and one can barely see the surf breaking on the coral rocks. At low tide, a few big coral boulders mark the line where hurricanes have broken off the big chunks and tossed them over the reef. We were told that Suva has had some very bad hurricanes and we became a bit apprehensive when the sky darkened and lightning started to flash out over the ocean.

Every hotel in Fiji Islands announces the serving of meals by means of a unique drum made from a hardwood log about two feet in diameter and about 8 feet long which has been hollowed out and pointed a little at the ends until it looks like a stubby canoe. It sits up off the ground in a V-shape rack with the opening tipped toward the drummer. He beats on the two-inch-thick side wall of the canoe with two heavy, short, clubs made of a dark wood. They look something like ordinary rolling pins. At the appointed hour for each meal, a Fijian boy goes to the grass shack where the drum is kept and, at a signal from the head waiter, begins: first with slow, steady thumps, then faster and faster until the drum clubs are only a blur, ending with two

Picture of
Kaula
No

Picture of
drum

or three big thumps. It is always the same, never any variation. It is a lovely, loud, sound that can be heard for at least a mile.

The Fijians are a proud people. They are polite, but there is no sign of an inferiority complex. They seem to meet white people on equal grounds much more readily than do the Indians. Some of the younger ones have adopted conventional haircuts and clothing, but most keep to their native ways. Their hair is very special, said to be different from that of any other race. It is kept about four to five inches long and is combed straight out from the head in all directions. It is dark brown, fine, and kinky, rather like long-fleeced sheep's wool, and it never lies down on the head but stands out as if electrified. It must require a great deal of combing and care. The men wear shirts and wraparound skirts which they buy ready-made in the Indian tailor shops. The women wear ankle-length, sleeveless, print dresses with an over-skirt that comes down to the knees.

*picture of
man & woman*

yes

January 2, 1939;

We visited the native market which is in a big open square partly roofed over to protect the things that might be spoiled by rain. There are many little stalls where the natives (about equally divided between Fijians and Indians) sell their food products or handmade articles such as straw hats, beads, and jewelry. Fish is sold here but we did not see any meat, probably because the Indians are vegetarians. Only the few whites use much meat and they must buy it in the stores.

In the afternoon we visited the museum which is located in the Botanical Gardens across from the Grand Pacific Hotel. The curator kindly showed us around and explained many of the exhibits, including a scale made of one of the great Fijian war canoes which he had made. It was complete and in working order so that he could demonstrate how the canoes were sailed. Actually they were not canoes at all but real

sailed

ships made from timbers and planks hewed from a special tree that was sacred to the King. Some of these ships were over 100 feet long and were constructed of two hulls lashed together with a timber platform. One hull was about two-thirds as long as the other and was used as a sort of outrigger or pontoon which could rise out of the water under strong wind pressure in the sail and thus achieve greater speed. The boat did not "come about"; the sail was simply swung around the mast and the double-ended canoe just sailed in the opposite direction. It had a steering oar at either end, one being raised and the other lowered into the water as needed.

The oars from the last great war canoe used by King Cakaubau in the early 1800's were on display in the museum. Their tremendous size impressed me more than anything else I saw in the museum. Hewed with a stone adze out of a single log (a heavy dark wood called levi), the blades are 13 feet long, 30 inches wide, and 5 inches thick, tapering to 2 inches along the edges. The shaft is about 7 inches thick and 19 feet long with a knob carved on the end so that the total length of the oar is 32 feet. It is said that it took four men to man one or lift it off the deck.

Between six and seven years were spent in the building of one of these war canoes. Much intricate carving went into the prow decoration and the crescent moon at the top of the mast, all the work being done with stone tools. The mast of King Cakaubau's 118-foot war canoe was 60 feet high and carried a lateen sail hung on a long yard arm.

It must have been quite a sight to see two of these great war canoes, each carrying something over a 100 warriors, engaged in battle. Imagine the two canoes coming together, each trying to ram the other, sails flapping and spears whizzing through the air as they closed in. Then the boarding and the general melee as warriors tried to club each

other or push the enemy overboard to the waiting sharks. There was a need, too, for taking a few prisoners home to eat, for it was thought that one might gain the strength and courage of a powerful enemy by eating him. As an exception to this rule, the British historians tell us that King Cakaubau ate a few Americans and so lost his nerve that he called in the British to take over his kingdom and protect him. Whether this is true or just a British fabrication, the fact remains that we lost a very beautiful winter resort by being either too slow or too indigestible.

The stone tools made by the Fijians and the other South Sea Island peoples are much better finished than similar implements made by our North American Indians. Instead of serrated or chipped edges the well shaped cutting edges were finely ground and polished. The stone axes were beautifully shaped and polished and so sharp that they would cut the hard woods almost like steel instruments. It is said that the natives thought nothing of taking six months to make one of these precious cutting tools. They also made special grinding stones on which to sharpen them.

January 3, 1959:

While at Suva we learned that one of the nicest resorts on the island was at Korolevu, about half-way back along the south coast toward Nadi. Consequently we left Suva by White's Bus about 3:00 p.m. and reached Korolevu about three hours later.

The mountains of Fiji are high sharp ridges radiating in all directions from a central point like the arms of a starfish, with the central point showing no sign of crater or lava flow as one might expect. This irregular pattern of ridges as seen on relief maps, is especially noticeable on the large islands but is also found to form

*Jump over to page 27
then
write out
geology
1-10-59*

the back bone of the two smaller islands. The curator at the museum in Suva told me that ~~some~~ small outcroppings of granite are found near the center of the large island, and some limestone, but he confirmed my observations that only three real volcanic craters are present. He has made quite a study of the island and although he is an anthropologist rather than a geologist, he has written the only book in existence on the geology of the Fiji group. In looking through this book later I found that it was written from the viewpoint of economic geology and that the two main items of interest were first, that gold had been discovered in 1855 in granite outcroppings near the center of the island and some twenty-five million dollars worth had been taken out before the mines were abandoned; and second, that very rich deposits of manganese had been discovered in several locations about the island and that mining operations had begun in 1955. We learned later that the ore is shipped to Lutoka on the west coast where it is crushed, refined, and shipped overseas, and that it is now the most important item of export.

In traveling half-way around the big island of Viti Levu I carefully observed all the cut banks along the road and the mountain ridges wherever it was possible to see the rock formation. Nowhere did I see anything resembling a true lava flow. In all the lower elevations along the coast the hard lava rock comes right to the surface with no more than a foot or two of decomposed rock and soil. However, on two occasions when we passed over ridges at about 1,500' feet elevation the road cuts exposed about 20 feet of decomposed lava and soil. The lava soils here are bright red as they are in Hawaii except, of course, the bottom land along streams and rivers where dark brown soils are in evidence.

Between Korolevu and Nadi is a little town called Sigatoka which is located near the mouth of the Sigatoka River. Nearby is a considerable area of sand dunes all overgrown with trees but nevertheless the only source of sand on the island. They were hauling this sand almost fifty miles to use on the new east-west runway being built at the Nadi airport. Gravel, we were told, was almost non-existent in Fiji so that beach sand derived from the coral reef must be used. This lack of sand and coarser sediments may be due to the predominance of volcanic rocks which, being very fine grained, disintegrate into fine loams and clay. Granitic rock, on the other hand, contains about 30 per cent quartz which remains as sand after the feldspar (60 per cent) and the hornblend (10 per cent) have turned into clay.

The big geological questions about Fiji are these: What happened to all the sediments that must have been eroded from the deeply cut and rugged topography of this island? How did Mother Nature contrive to build volcanic islands without volcanoes and lava flows?

It is my belief that the Fiji Islands, and all of the lava peaks projecting from the deep floor of the Pacific, are the direct or indirect result of cosmic collision. Before going into detail as to just what I think happened, let us first consider, for background, the probabilities of cosmic collision.

1. No fact of science is more certain than that meteorites collide with the earth. This is not a supposition or a theory, it is a fact. Larger and larger meteorite craters are being found from year to year and where is the scientist who can prove that still larger features such as ocean basins are not meteorite craters-- collision craters?

If collision is a fact, then what are the probabilities of large-scale collision between the earth and bodies of asteroid size? How many have occurred in the four-or five-billion-year history of the earth? We might start by eliminating the first three billion years of the earth's history since most of those secrets are locked within the crust of the earth. The remaining two billion, or 1,850 million^{year}, as the geologic time charts usually give it, have been recorded in the stratified and metamorphic rocks of the earth's crust. This outer crust can be searched for evidence of collision.

The evidence which I see is found in the great nonconformities that separate the major eras and the lesser periods into which the eras have been divided by geological science. Orthodox geology divides the geologic time chart into five major eras; starting at the bottom with the oldest, they are called Archeozoic, Proterozoic, Paleozoic, Mesozoic, and Cenozoic. Each of these eras is separated from the next above by a very obvious nonconformity which, according to the orthodox geologist, marks the end of a long era of sedimentation and erosion. This is followed by orogenic movement (mountain building) and then another long cycle of sedimentation and peneplanation (the long-continued process of eroding a region of low relief into a bas-^E leveled plain) until the very roots of the mountains are showing. Then a new series of sediments is laid down on this old eroded surface which marks the boundary between it and the next era. Between the major eras there are found many lesser surfaces of erosion that mark the boundaries between the periods into which the eras have been divided.

Collision geology claims that these nonconformities marking off the eras are the erosion surfaces caused by major collisions in the earth's history, and that the boulder conglomerates and gravels

immediately above were laid down by the same process. In other words, collision-flood scoured the land surfaces down to bedrock and re-deposited all this rock debris again as soon as the fast-moving waters had slowed down enough to redeposit. Re-adjustment of the earth's crust (mountain building) also took place immediately following the major collisions. Each of these collisions was followed by a short period of adjustment that might have lasted a few thousand years and then the vastly longer periods of uniformity, in which time the forces of erosion and sedimentation were not greatly different from those we experience today.

One difficulty with the orthodox explanation is that it calls upon ordinary forces of erosion and sedimentation to act in the past in a way in which they cannot act today. Sir Charles Lyell, father and founder of modern orthodox geology laid his chief premise: "That no causes whatever have changed the earth except those that still do so under the eyes of man". These forces do not today erode hard rocks down to nearly level surfaces, especially, hard, tilted strata, which are often found as the base of a nonconformity; nor can slow-moving water deposit boulder gravel immediately on top of such a surface, yet many such deposits occur.

Today, on nearly flat surfaces, our streams can only deposit fine sediments. Continental ice can scour and cut hard rock formations to a nearly level surface. Yet many such wide surfaces occur far from any known glaciation. A cross section of these old peneplanes shows that cleanly washed gravels were laid down on equally clean eroded surfaces. This is not the natural way. Any land surface that has reached a fairly level ^{plane} surface and built up a deep soil and a still deeper decomposed subsoil, will be found to lack any sharply defined

surface at bed rock. This decomposition is what nature is now doing, but only since Pleistocene time. (Note: Orthodox geology usually considers Pleistocene time as beginning about two million years ago and including the four ice ages up to the beginning of recent time (historic time). In the field, the Pleistocene gravels are those unconsolidated rocks that lie upon the older Pliocene consolidated rocks and thus are easily distinguished because of the well defined zone where the bottom of the Pleistocene meets the cleanly eroded surface of the older formation and again at the top where recent streams have cut into the irregular surface of the Pleistocene.) The Pleistocene gravels and finer sediments are the most common sediments found below the 5000 foot contour, and I would estimate, make up 90% of the total unconsolidated sediments. The other ten percent are the recent sediments that result from the erosion of deep gullies into the Pleistocene gravel hills and alluvial fans that are so wide-spread at all lower elevations in Western United States. In other parts of the world, as we shall see, the Pleistocene gravels are almost entirely missing.

According to collision-flood geology, all of the Pleistocene gravels were laid down by a world-wide cataclysm that occurred about 11,000 years (B.P.) which we deduce from the many carbon 14 datings that have been made over the last decade that range around this date, plus or minus a few hundred years. These carbon 14 dates have been taken from many sources, the Pleistocene lakes that are scattered over the world; sudden changes in climate indicated in deep sea sediments by type of fossil found there, and the carbon 14 dating of Pleistocene animal bones.

The Pleistocene gravels always appear quite uniformly fresh from top to bottom and are easily distinguished from the recent sediments by the much gentler slopes of the latter. Everywhere, the great Pleistocene alluvial fans, river terraces and deltas contain much

alluvial

coarser gravel and are laid up in much steeper slopes. Only a great oceanic flood moving at considerable velocity could have produced the boulder gravel deposits or laid up into the canyons, alluvial fans at forty-five degree slopes.

Orthodox geology then, considers the Pleistocene era as covering a period of about 2,000,000 years in which time four separate ice ages occurred with interglacial periods of warmer climate.

Collision geology asserts that all the Pleistocene gravels were laid down at once by oceanic flood accompanied by world-wide rainfall that was far beyond normal and lasted for perhaps two or three years. This abnormal ^{precipitation} precipitation caused by great quantities of dust and gases thrown into the upper atmosphere and by mixing of warm and cold ocean waters as well as air currents, caused excessive snow and ice to accumulate on the high mountains in the tropics and temperate zones. This has led the orthodox geologist to suppose that the ice age cold spread all over the globe.

Go back into the older formations of consolidated rocks and almost without exception, the unconformities, disconformities and nonconformities are clean, sharp breaks. This is because the terrific cutting power of oceanic floods moving at unbelievable speed away from the collision points, cut everything away of an unconsolidated nature, down to bedrock and carried the debris away to be deposited elsewhere. No river has ever had the power to erode vast areas of land down to near-level, hard bedrock, and then deposit on that surface a layer of boulder gravel, yet this occurrence ^{is not} is not uncommon. Oceanic flood could scour such surfaces and the large boulders would be first to drop on the bare rock. Cross sections of such peneplane surfaces are seen near the bottom of the Grand Canyon.

It is clear that the theory of Uniformity cannot explain penetration yet there are many more major features of the earth that

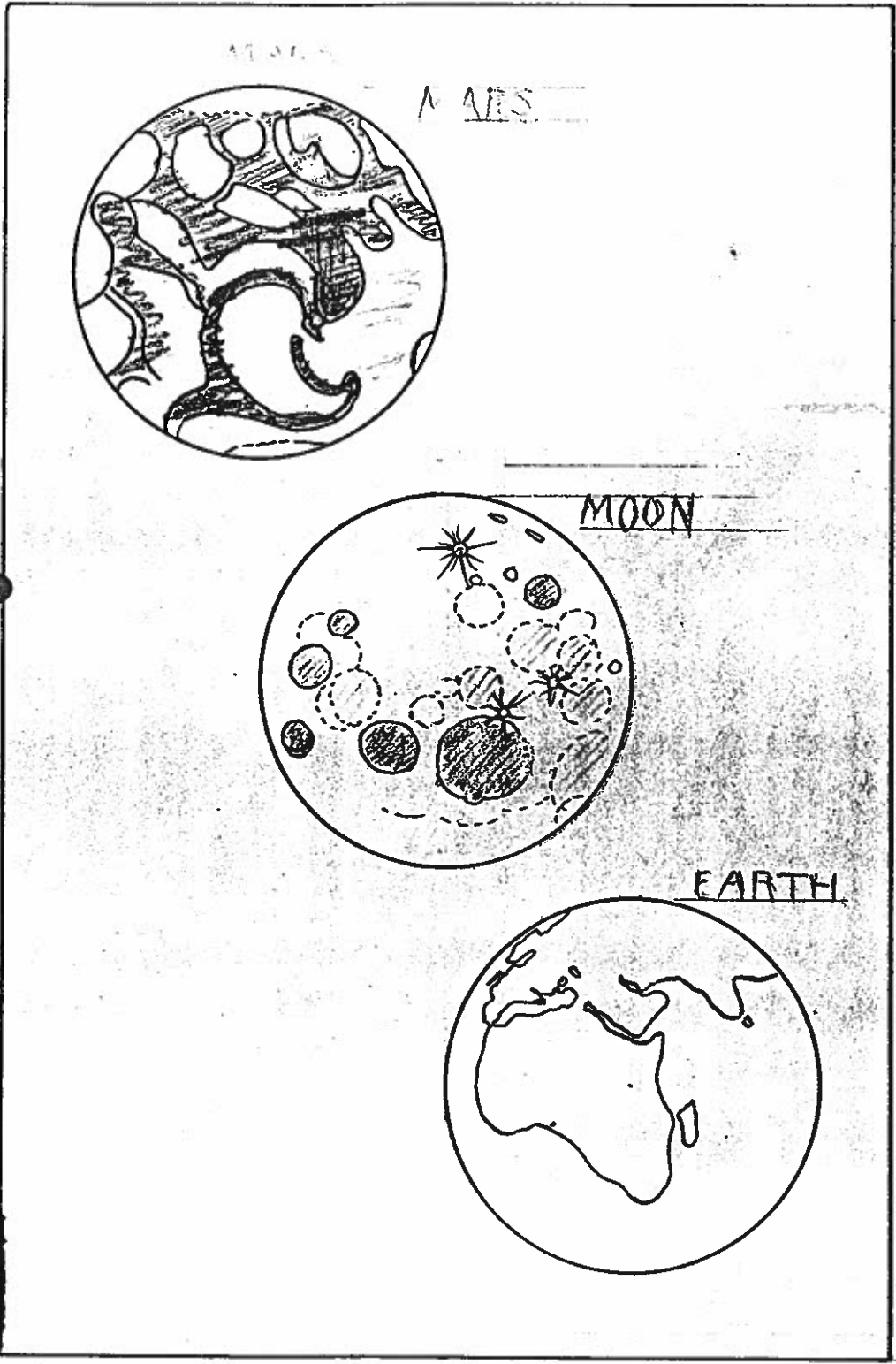
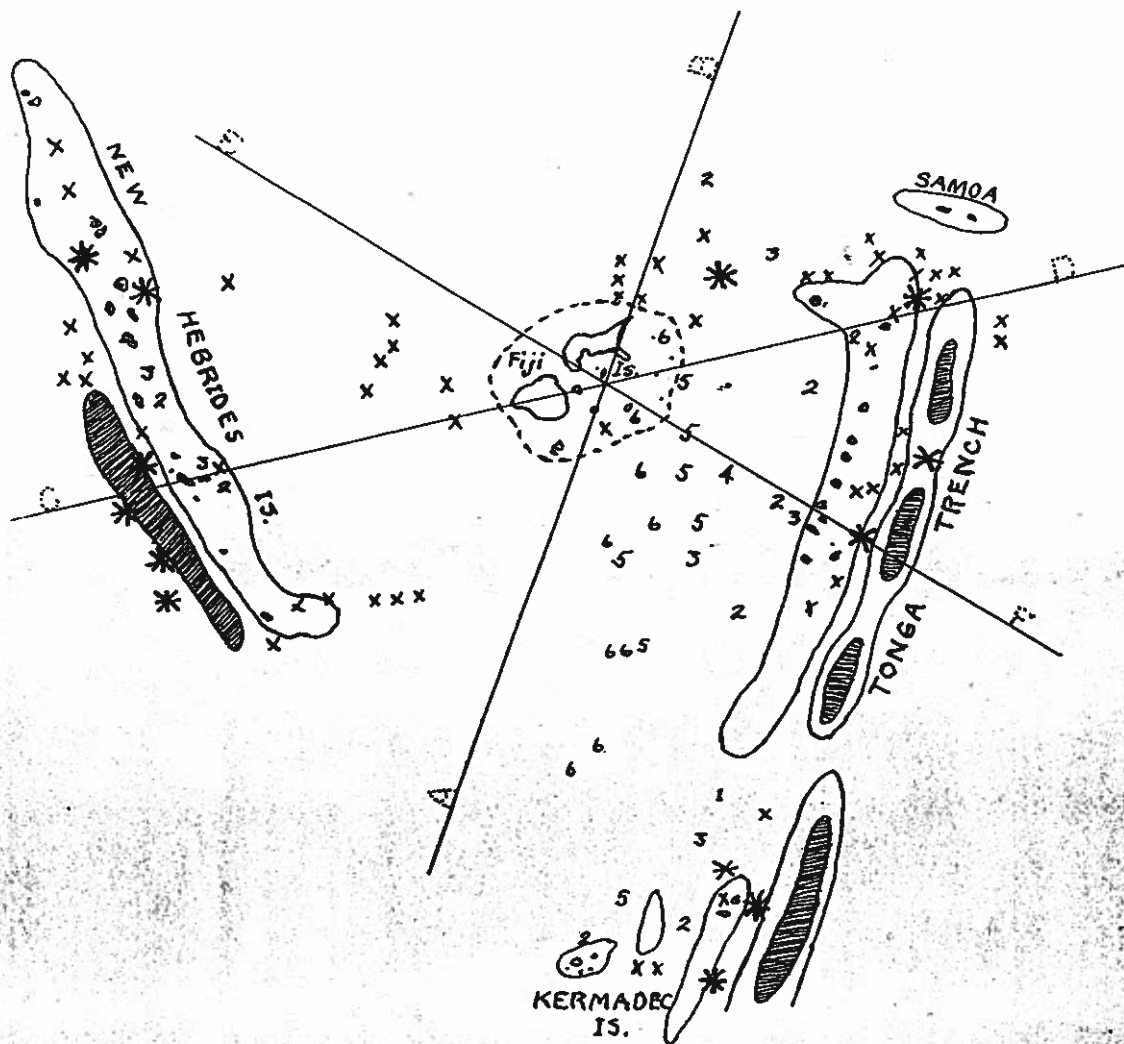
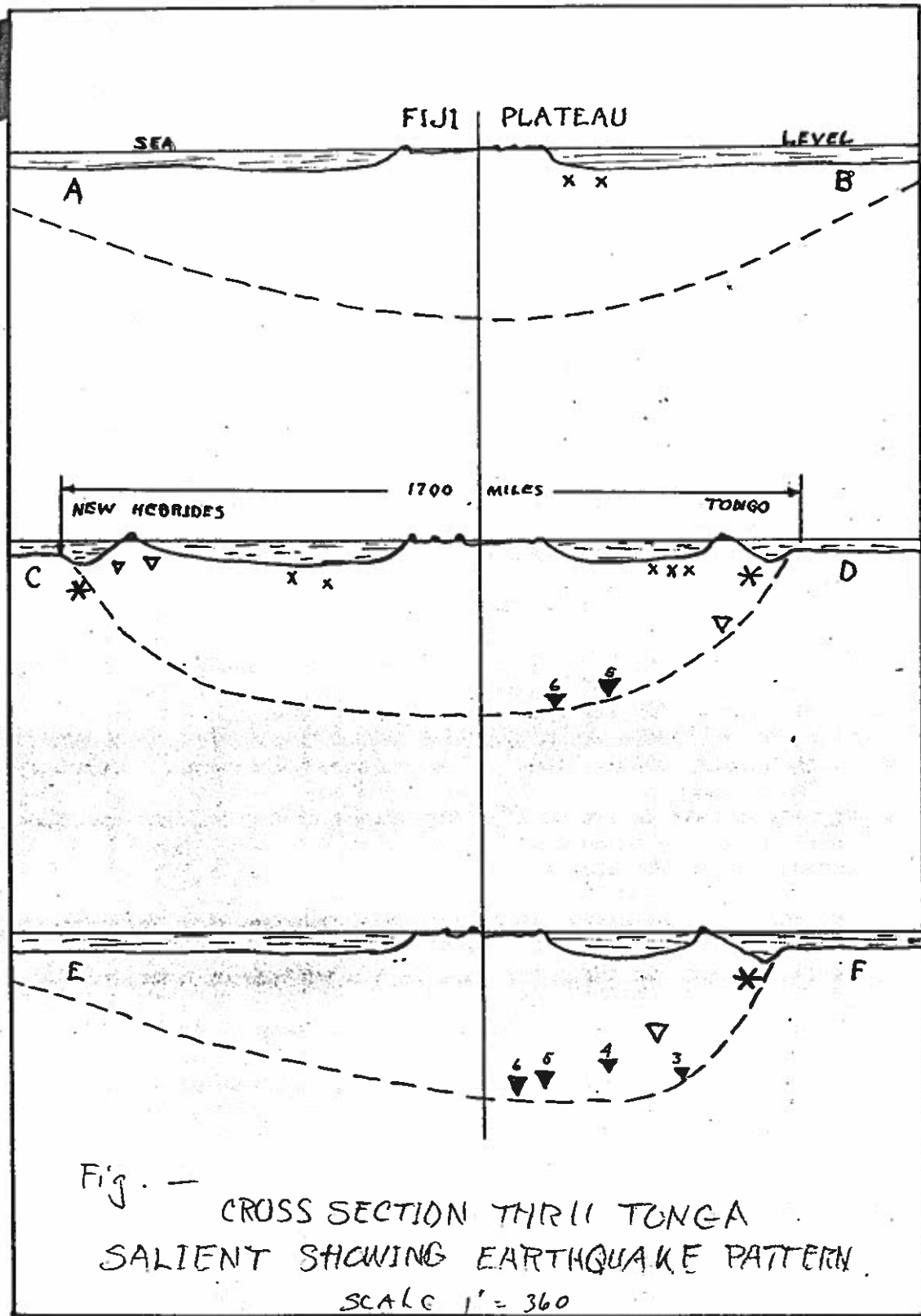


Fig —



Scale 1" = 360 mi

Fig.



Faint note

cannot be explained by this theory. (Father of the theory of Uniformity was Sir Charles Lyell, (1797-1875) English barrister who gave up the law to expand and weld together the original ideas of James Hutton (1726-1797) and John Playfair (1748-1819). Lyell had great ability as a speaker and writer and is generally acclaimed the outstanding figure in the history of geological science. He fought the catastrophists and the religionists who preached biblical deluge and said that the true scientist had no right to speculate but must project present natural forces into the past to ascertain what went on in the past ages. ^{*We repeat*} His classic statement of this premise ~~is~~ "That no causes whatever have changed the earth except those that still do so under the eyes of man." ^{*repeated*} "That given sufficient time, the ordinary forces of erosion, sedimentation and vulcanism can account for all of the earth's physical features.") Not all of the earth's physical features were then known. For example, the origin of submarine canyons, submarine slopes, island arcs, and many lesser phenomena. Orthodox geology has either failed to give any answer or has offered speculations that are easily discredited.

Getting back to Fiji: It is probable that the Fiji Islands and the entire plateau on which they sit is the product of a major collision with an asteroid which struck at a steep angle, coming in from a little west of north. This is not the Bermuda collision, but one which probably occurred many millions of years before. Vaporization of a great part of the asteroid and probably an equal amount of the earth's crust would be the first effect. this part being spread far and wide for thousands of miles. The second effect would be the rebound of lava to form the central peak or plateau that we now call the Fiji plateau. (See article in Oct. issue 1960 SCIENTIFIC AMERICAN, "High-Speed Impact", page 128. In these tests velocities up to 20,000 feet per second were used.) This central peak is seen

in the large impact craters on the moon, but on the earth, where gravitation is six times as great, the central peak or plateau would only be formed by much larger impacts and then the central mound would be so large as to be unrecognizable. We must therefore look for a crater wall of matching proportions and this we find in the Tonga Island arc on the east, and the New Hebrides arc on the west; each with its accompanying deep trench on the outside of the arc. Around the central plateau is the deep basin of the crater, although its outlines are far from perfect. (See Fig. 1) In further support of this theory, we find that this area has been the source of most of the world's deep earthquakes, the epicenters of two of the strongest ever recorded were at a depth of about 250 miles beneath the basin of this crater, to the southeast of Fiji. (See "Seismicity of the Earth" by Gutenberg & Richter, page 49). This would seem to indicate that the crust of the earth was penetrated to a depth of at least 250 and perhaps 300 miles, and that the cooling of the magma and re-adjustment of the deep-seated rocks is causing the deep shocks. Nearer the rim of the crater, at an intermediate depth, more shocks are being recorded and the very shallow ones are just under the island rim and the most numerous of all. Beyond the paralleling oceanic trench, where the deep sea floor is quite uniform, very few shocks have been recorded. The Fijian Plateau itself, is practically free of earthquakes, and as we have mentioned, practically free of volcanoes. This lack of seismic activity and volcanic evidence may be due to the vast size of this plateau, some 300 miles in diameter. Perhaps it slumped down a bit transmitting its pressure through the molten magma below to the outer rim of the crater, where this pressure was relieved by the formation of a chain of volcanoes, now seen as islands. So large was this central body of lava and so slowly did it

Picture of New
Cresson

map of Fiji
showing sh.

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cool, that some granite was able to crystallize out of the magma. Later collisions in distant parts of the globe, caused oceanic floods that surged over Fiji and the other surrounding islands, removing all of the loose material such as rock, cinders and ash and probably the crater rims too, so that all we see remaining is the volcanic necks and fissure flows that form the skeleton of a volcano. We are looking then, at the skeletons of true volcanoes, but with all the outward flesh removed. All of the Hawaiian islands which I saw excepting the big island of Hawaii, are of this kind, as are most of the mountain peaks of Eastern Australia. I looked in vain for any sign of Pleistocene gravels in Hawaii and in the greater part of Australia, but New Zealand, especially South Island, is literally covered with such deposits. New Zealand, of course, is geologically new, its high mountains are angular and of recent elevation.

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We arrived at Korolevu about 5:00 p.m. and after checking into our room we walked along the beach under the coco palms to watch the sun go down. It was a beautiful sunset with lots of color in the dark storm clouds. The tide was out and we picked up many shells. One kind called "catseye" is much in demand for beads and other types of jewelry. I found about a dozen but lost them all to a little girl who said she was making a collection. I didn't want them, so I gave them to her--she was blonde and about five feet, five inches tall and certainly would have looked well in a string of green catseye beads.

Dinner was late that evening because the local natives always put on a war dance and feast on Saturday night, which this was. Folding chairs were set up outside the burra, a grass shack dining

hall, facing the ocean and three men tourists were chosen to be guests of honor. The hotel manager explained the native custom of welcoming guests by drinking the Yaqona or Kava--a hot, peppery drink made from the dried root of a local plant. When taken in sufficient quantity it produces a partial paralysis of the limbs so that the drinker goes home with a clear mind but with a very wobbly set of legs.

The ceremony began with the appearance of about 20 Fijian natives, dressed in all their war finery, who seated themselves crosslegged on the ground in a square in front of their guests of honor. The chief then proceeded to make the drink in a large Yaqona bowl. This is done by mixing the dry pounded root with water, and after the plant has given its ^{flavor} to the water the dregs are sieved out with a hank of raffia. An assistant poured a little water in the bowl and the chief mixed it thoroughly with his hands. More water was added, then more Yaqona root, until the bowl was filled and the mixing process complete. Another assistant brought the hank of raffia which the chief dipped into the bowl of liquid and wrung out with his hands. He handed the raffia to another assistant who shook out the dregs and handed it back. This went on through a half-dozen wringings until the chief was satisfied either that his hands were clean or that the drink was hot enough.

A large coconut-shell cup was then brought forth which the chief proceeded to fill by wringing out the raffia which had been dipped into the Yaqona bowl. With proper flourishes the cup was presented to the first guest of honor who was supposed to drink it down without stopping. This he did, and when it was down all the natives clapped their hands twice and said "Aah-ya!" as one voice. Next the guest of honor's Fijian host (one had been assigned to each guest) was served the cup and he drank it down to the same loud voice of approval, "Aah-ya!"

The same routine was followed in serving the other two guests and their attendant hosts, and finally the five body guards were served. The chief didn't bother to drink his own brew, he just washed his hands in it.

This ceremony was followed by an authentic Fijian war dance performed by 24 natives and their chief all dressed in costume and war paint. Twelve of the natives had war clubs and 12 had spears and they formed a square, three rows of men with clubs on one side and three rows of men with spears next to them. The chief remained in front of the group as leader. A native began to beat a drum and the rest of the tribe kept time by clapping their hands and repeating the chant. The dancers began well out toward the beach, but at the end of each stanza of the chant they approached two or three steps closer to the crowd of tourists, each time working themselves up to a higher pitch of excitement. Each spearman grasped his ten foot spear near the middle and by a violent jerk of the forearm and wrist produced an intense vibration of the ends of the spear, giving the impression that he was working himself into a frenzy and shaking with rage. The chief was especially good at this and as they came closer to the crowd he began to make short rushes at various spectators in the front row, threatening to throw his spear. By this time the front line of dancers was practically up to the front row of spectators and the chief was almost in their laps. The frenzied warriors, grunting and shouting by turns, jumped into the air and at the same time whirled a full 180 degrees, spears, clubs, and all. How they missed each other I'll never know. In fact, I wasn't sure the chief was going to miss me. I hunched down as low as I could in my chair and I know that spear handle whizzed over my head each time the chief reversed his direction. Suddenly, it all came to a stop. The audience remembered to clap loudly, the tension was broken, and we all adjourned

to nearby tables under the coco palms where we feasted on barbecued steak, yams, and various kinds of salad.

January 4, 1959:

Up at 7:30 a.m. and after breakfast took a boat ride out to the coral reef where we looked through glass-bottomed buckets held in the water. Unfortunately the buckets leaked water and spoiled the view, but we did see hundred of little fish, bright peacock-blue in color, and many different kinds and shapes of coral. The native guide said that there were really only three kinds of coral but that each kind had many variations in color and structure.

Back at the hotel I bought a yagona (Yagona is pronounced Yan Gona) bowl but Mrs. Kelly wouldn't allow me to buy any human flesh forks to go with it.

*Pictures of
Yagona
fork*

We returned to Nadi by taxi.

January 5, 1959:

We had arranged with the boy at the Nadi Hotel to wake us at 3:30 a.m. so that we could get a taxi and be at the Nadi airport by 5:00 a.m. for our flight to Auckland, New Zealand. The boy awakened us alright, but informed us that the plane did not leave until the same hour on the sixth. We checked our tickets and found that he was right, much to our chagrin, for we might have stayed a whole extra day at Korolevu.

Most of the people in Nadi are Indian because it is a farming district and the native Fijians do not take to farming. The women all wear native costume, but most of the men wear European-type shorts and usually go about with bare feet.

The little hotel at Nadi was small but clean and the food was good. The waiters were barefoot Fijians who brought the menu on the back of a fan which they held up before the diners in order that they might make their selection. There were spacious lawns about the

hotel and beautiful flower beds under the coco-palms. The town of Nadi is probably about 50 years old, judging from the look of the buildings, and its streets are lined with beautiful large trees that seem to bear out this estimate of age. The main street is only two or three city blocks long but its pavement extends on for about five miles through an avenue of beautiful trees to the International Airport. This was an important airbase during the war, ^{where} some 45,000 troops were stationed here, with the usual barracks, recreation facilities, water works, sewage disposal plants, etc. Pan American, ^{American} Qantas, and ^{SP} some of the other world airlines have taken over these facilities and are operating them ^{for} from their own personnel and the stream of overnight travelers who pass through, Nadi being the main refueling station between Hawaii and Australia.

January 6, 1959:

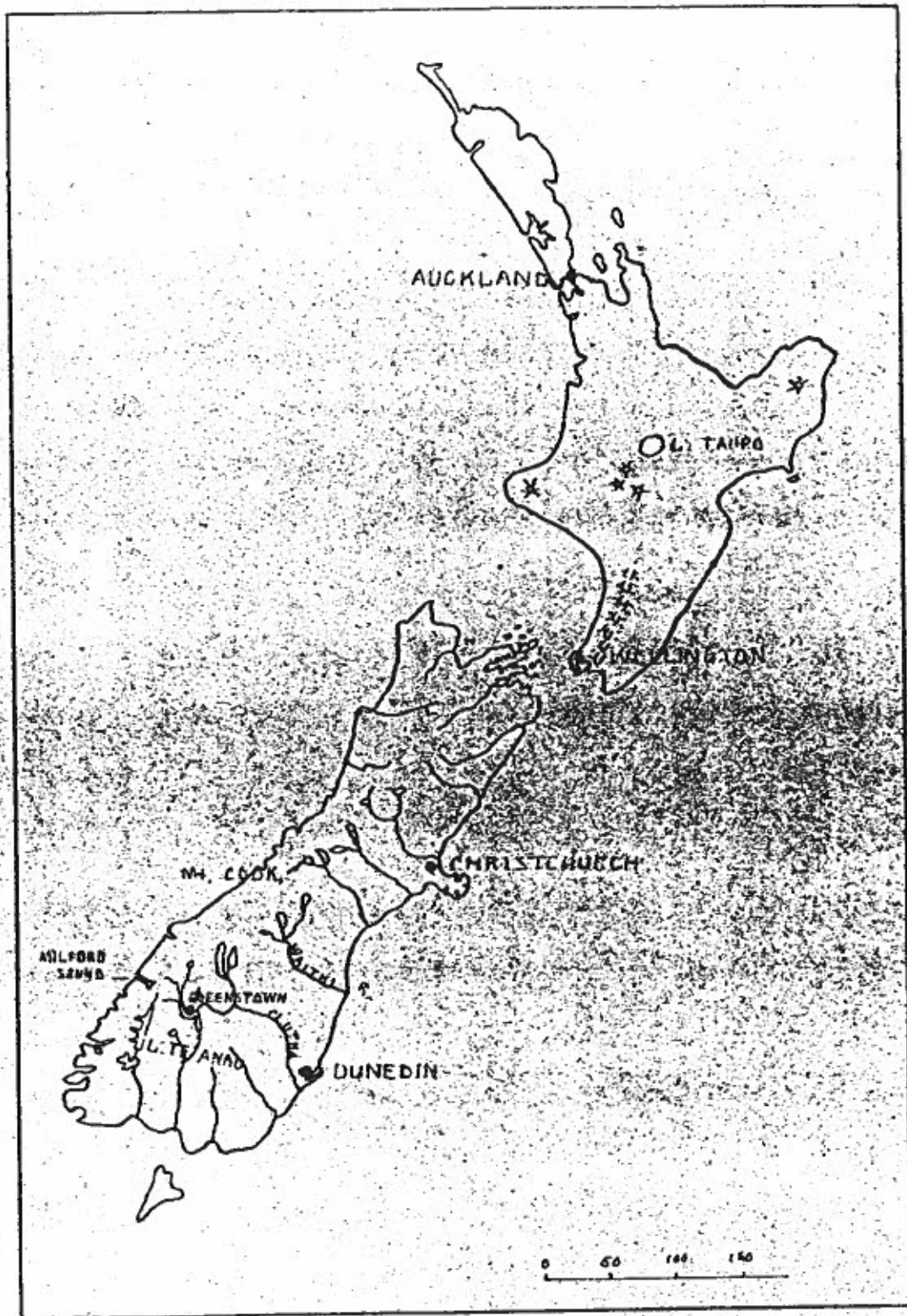
We arrived at the airport at 5:30 a.m., but the incoming plane was late and takeoff was delayed until 6:30. When we were some 20 miles out to sea, it was announced that one propeller would not feather properly and that it would be necessary to dump the fuel load and return to Nadi for repairs. This, they said, would only take twenty minutes or so and that we should remain on the plane. However, after two or three tries the propeller still would not operate so we were told to disembark and go across the street to the hotel where we could have breakfast at Pan American expense and wait for further orders. At about 10:00 a.m. they came: It would be necessary to install a new meter and the plane would not get off until midnight; all passengers were invited to take a bus trip to Korolevu, hire a taxi and go where they pleased, or get a room at the hotel--all at Pan American expense. We were to be back at the airport by 10:30 that night.

We chose to take a taxi to Lautoka, the second largest town on

the island and about 20 miles northwest along the coast from Nadi. The road is paved all the way from Nadi to Lautoka and the entrance to the city is enhanced by another avenue of beautiful old trees. Lautoka is a clean, enterprising town of about 35,000 population, with a fine new hospital, schools, and parks. We returned to the Mocombo Hotel at the airport for a late lunch and a long afternoon nap.

Finally, at midnight, the plane taxied down to the end of the runway but, after a long warmup, it was decided to take it back to the hangar for another hour and a half while they fixed the pressure gauge on No. 1 engine. With that done we took off for Auckland at 1:30 a.m.

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CHAPTER IV.

N E W Z E A L A N D --- N O R T H I S L A N D.

In TARGET: EARTH we produced many lines of evidence to show that the last major meteorite collision occurred in the northern hemisphere between 10,000 and 12,000 years ago*. That it shook the earth to its very core and changed the position of the polar caps by more than 2,000 miles, a movement of 30 degrees as measured on the globe. As we approach New Zealand and Australia I should like to summarize some of that evidence so that the reader may better understand the reasoning behind the geological phenomena described later in this book.

Geological science long ago explored and described the glaciated areas of North America, a huge circular shield that included all of northeastern Canada and extended south into the United States. It was said that this ice cap was at least two miles thick over Hudson Bay and that at the close of the Ice Ages, this great mass of ice moved off the continent in all directions, even to the north into a supposedly colder region. This latter fact was proved by the glacier-made grooves in the rocks of far northern Canada, yet the far northern islands of Canada and the north tip of Greenland were never glaciated. Another mystery was the plain evidence of recently elevated shorelines (as much as 500 feet) over a great part of this area. Geologists have offered the theory that the melting of the ice relieved the load on the earth's crust and allowed it to rise. That it did rise, there is no doubt. That the ice was there and did melt, there is no doubt either.

* See "RADIOCARBON DATING" by Dr. W. F. Libby in SCIENCE, 3/3/61, page 623. Dr. Libby gives date as 11,400 years ago plus or minus 200 years, as time when a great cataclysmic event occurred.

More important: What caused this great accumulation of ice in North America far below the Arctic Circle while in similar low-lying lands even farther north in Alaska and Siberia, no ice accumulated?

It was first pointed out in TARGET: EARTH that all of this glaciated area of North America could be encompassed in a great circle the size of our present Arctic Circle with its center at Akpatok Island near the mouth of Hudson Bay. I have since come to believe that this center should be moved about 300 miles east to a point in the Gulf of Labrador, 50 degrees north by 60 degrees west. (See Figs. ____ & ____)

This polar center agrees better with the glaciation found in Norway and the British Isles and also with that found along the Australian southern coast, which was the edge of the old Antarctic Circle.

That the polar caps did shift and shift quickly there is little doubt. This is probably best proved by the vast deposits of sand, gravel, and muck, that has been deposited all across the lowlands of Alaska and Siberia. This material is now permanently frozen ground but it had to be deposited by running water. Farther east in Canada, the ice cap acted as a cover and no stream gravels were deposited there. Also found in this frozen muck (which consists of sand, gravel, mud, tree trunks, leaves and other debris) were the remains of mammoth, saber-toothed tiger, woolly rhinoceroses and other extinct Pleistocene animals. How were these large animals so quickly frozen?

Ivan T. Sanderson in an article entitled "Riddle of the Frozen Giants" (Saturday Evening Post, 1/16/60.) discussed some of these questions. He stated that experts in the frozen-food industry estimated that it would require temperatures in the realm of 150 degrees below zero to freeze these large animals quickly enough to produce the small ice crystals that are necessary, — for long preservation. In this connection he points to the fact that full grown mammoth have been found in Siberia in a perfect state of preservation. In the upper Yukon Valley of Alaska, these large

Fleistocene mammals are found mingled together with some species that have survived into modern times. Gold miners who mine with steam jets along the Yukon, find these animal remains frozen and all mixed together, bodies and limbs torn apart, as if by some cataclysmic blast. Farther south, in the United States, the bones of the same species have been found, sometimes heaped together in a common grave. This, Sanderson says, indicates death by some great catastrophic force and he offers the Hapgood Theory: That from time to time, the polar ice caps grew to tremendous size, finally toppling over and causing the earth's crust to shift while the depleted oceans over-ran the lower elevations of the earth. Sanderson envisions the mammoth and other large animals as having been killed by quick-freezing winds that came down from the stratosphere, winds that tossed these big animals about like straws and tore them apart. At the same time the crustal movement produced the oceanic floods that buried these animals and moved them into the Arctic region.

In the past, most scientists have agreed that the inclination of the earth's axis is impossible; that the momentum of the earth in its orbit ($18\frac{1}{2}$ miles per second) together with its angular momentum about its axis is so great that nothing could change its alignment. They see more reason to believe that the earth's crust has slipped over the mantle and core. However, there are some objections to this slippage: 1. The earth is not a perfect sphere. 2. The crust is not of uniform thickness or uniform material. 3. It is filled with fractures that would break open and prevent it slipping as a unit. 4. The earth's crust is so thin in comparison to the mantle and core that even admitting a liquid lava joint between the crust and the mantle, it would be something akin to slipping the skin of an apple over the flesh. The problem is how to hold the apple core while slipping the skin.

Head-on collision by a large meteorite on the approaching side of the rotating earth's disk, could cause a braking effect which could hold back a section of the crust while the heavy interior continued to turn. Or a blow on the receding side of the earth's disk could increase the speed of rotation and possibly slip a section as inertial forces held back the core. Obviously, there are numberless collision courses possible and at as many different velocities. More important questions might be: What are the frictional forces involved in slipping the whole of the earth's crust over the mantle? How big must the striking body be and what velocity is required? Some of these questions were answered in TARGET:EARTH, (See Mechanics of Collision pages 175 to 188) In this section Dacheille pointed out that the comparative area of the disk of the earth to the disk of a 600-mile diameter spheroid would be in the ratio of 178 to 1, and that the mass of the earth compared to a 600-mile spheroid would be in the order of 2370 to 1. (See Fig. ___*)

Besides the mechanics of collision we must consider the temperatures involved. According to Dacheille, the surface or thin skin temperatures of such a body while yet 80 miles away from the earth would be in the area of 7,500 degrees C. and during the few seconds of impact it would rise into the millions of degrees, vaporizing most of the meteorite and a large section of the earth's crust. It would seem then, that a 600-mile meteorite would burn its way into the earth rather than striking a jarring, hammer-like blow and that such a compressive, elastic kind of punch would not have much effect in slipping the crust of the earth. Rather, it would probably vaporize its way into the earth in a gigantic explosion that might end in a 2000-mile-wide crater of boiling lava, later to cool as one of the basins of the deep ocean. I see these same basins in the large craters and maria on the moon.

It may be that we tend to think of the earth as a flywheel rotating about a rigid axis whereas, it is really a plastic ball floating freely in frictionless space and constantly subjected to the kneading action of the sun and moon as the tidal forces work the rocks of the crust as well as the waters of the oceans. It may be then, that our plastic earth as a whole, can quickly re-arrange its collision-altered mass to a new symmetry of form and a new alignment of axis.*

Those who stress the laws of probability will say that the chances of such a large body striking the earth are in the order of once in several hundred million years. This is probably true. The signs of ancient glaciations are few and so limited that we cannot be sure of any except the one in Permian time, although the oceans may cover glaciations of which we have no knowledge. The great disconformities and non conformities in the rocks of the earth indicate that many collisions have occurred but only in the Permian and the Pleistocene is there good evidence that new polar caps were formed.

Sea level changes and the rise and fall of continents are explained by orthodox geology, either, as the result of re-occurring ice ages locking up the ocean waters in the polar caps or as diastrophic movements originating within the earth. Collision geology explains these things as the re-adjustment of the earth's crust following major collision. Some continental shorelines were raised and some were lowered but in general the movement was upward because of the addition of the colliding bodies. The orthodox geologist has no visible proof that the oceans were once 200 or 300 feet below

* It is known that high-speed centrifuges with flexible shafts run with less vibration than with rigid shafts. This is because the flexible shaft finds its own best alignment.

their present levels because he cannot see the old submerged shorelines. It is difficult enough to make out the raised shorelines. His only evidence rests on submarine canyons and continental shelves which he supposes were cut while the ocean was at a lower level. The trouble with this argument is that many submarine canyons have been cut to a depth of eight and even ten thousand feet below sea level and there is no uniformity to the depth of shelves. We can hardly expect to believe that the oceans were 8000 feet below their present levels while the poles bulged under miles of ice.

Perhaps the best evidence that the polar caps have been shifted lies in the glacial evidence of of this circular area or spot in the northern hemisphere while at the opposite pole a glaciation of the proper age is found to support it. There is, of course, much evidence in the warmer climes between to support the collision theory and this will be the main concern of our further geologic observations.

The animal extinctions and survivals are an interesting phase of the collision-flood theory. We begin to see the necessity of re-evaluating our theories of evolution. It looks as if sudden extinction was the cause rather than a slow process of evolution in which they became ill-adapted to their environment. Apparently those few animals survived that happened to be at high elevations and therefore escaped the floods. These were the smaller and more active animals. In fact the pattern of survival has always been that the smallest and simplest forms have continued longest unchanged, especially those that lived in the sea. Algae, for example, one of the most ancient forms of life found fossil, still survives in vast numbers and practically unchanged from the beginning. This does not prove evolution. The large reptiles and the large mammals were exterminated by collision floods because they lived by right of strength in the lush pastures of the river lowlands. Lush pastures

are rarely found at high elevations above sea level in the tropics. Only in small areas of Africa, India, and New Guinea are there high elevation pastures that can support elephants the year around. All other high elevations of the world are either too dry or too cold for at least half of the year so that the large animals must migrate to lower elevations to survive.

The only large animals to survive in North America were the elk, moose, bison and musk-ox, all of which are known to migrate to high summer pastures. We know too, that this last collision flood occurred in the summer time because green grass and flowers were found in the stomach of a mammoth found in Siberia. High elevation then, was a necessity to survival but the animal of whatever size would need to escape the icy winds, volcanic eruptions, earthquakes and storms, all violent beyond our wildest imaginings.

The amount of oxygen burned out of the earth's atmosphere by so huge a meteorite (especially those containing a high concentration of iron) might have been a considerable percentage of the earth's total supply. This leads easily to the speculation that the gigantic size of the Pleistocene mammals and the reptilian giants of the Cretaceous resulted from a richer mixture of oxygen in the air. Perhaps there may be a very slow but steady increase in the oxygen content of the air through photosynthesis which our biochemists have not detected because of the newness of this science. Tests may need to be spread over hundreds of years to detect a change. During long periods of time in which no collision occurred both plants and animals may have grown larger through the gradual enrichment of soils, foods, and air. A great collision disrupting this Eden-like world would kill a great part of all plant and animal life and reduce those forms that survived to very severe hardships for many generations to come. "Survival of the fittest" long ago became natural law.

The reader may wonder why this theory of cosmic collision and axis change has not been given more publicity and a thorough discussion by the scientific authorities. The answer seems to be that authorities are the last people in the world to consider and accept new ideas in their own field. Many of the world's great scientists have been guilty of this resistance. (See "Resistance by Scientists to Scientific Discovery", Bernard Barber, SCIENCE, 9/1/61, page 596) When confronted with evidence they cannot refute, these objective thinkers change the subject to personal questions about the advocate's "background". "Where did you get this idea? Who is your authority for these statements? What institution are you connected with?"

Jan. 7, 1960. It was a seven hour flight from Nadi to Auckland, much of the way cloudy and threatening rain. As we came in over the land we looked down through holes in the clouds on bits of shoreline and then green hills with canyons filled with forest and giant tree ferns.

The airport is 20 miles out of Auckland but the bus finally dropped us at the Grand Hotel, (said to be the best in the city) where we had reservations. It is grand indeed! Built about 1880 in the most classical British tradition, the ceiling in the dining room was 30 feet high with Italian scroll work and French chandeliers of great elegance. The grand stairway was a classic too but the elevator was an afterthought placed in the center of the stair well in an openwork cast iron shaft. Grandest of all, were the genuine gold-plated faucets in the washbowls of the bedrooms. The tub and toilet were down at the end of a heavily carpeted hall and served both men and women.

Auckland is a very striking city! Set astride a narrow peninsula which forms a waist near the center of North Island, it faces both the South Pacific Oceans and the Tasman Sea, and the harbors on either side are the kind Californians dream about----big, land-locked

Auckland a very striking city
Harbors - bays -

Jan. 7, 1960

basins with deep water right up to the shores and with endless indentations and intervening peninsulas. Manukau Harbor on the west has an area of about 100 square miles and a narrow entrance about two miles wide. On the east coast an equally large and beautiful harbor is protected by a group of islands in front and then the large Hauraki Gulf beyond, so that entrance in time of storm is no problem. Auckland, then, is twice blessed, with two near-perfect harbors, one on the east coast and the other on the west coast. A canal less than two miles long at the west end of the city would join these two harbors and save over 500 miles of steamship travel on a through trip to Sidney Australia.

Our tour of the city took us up on a low mountain behind the city where, on a clear day, both harbors and the city can be seen at the same time. We were denied the view because of rain and fog, but we did see the wonderful rain forests with the dense jungle-like growth of giant tree ferns. The pastures (pastures, they call them) are as lush as any High Sierra meadow, and are completely devoid of any weed, growing only pink and white clovers and the best imported grasses knee-deep and covering most of the 40,000 square miles of North Island. The average rainfall is about 45 inches which is spread about evenly over every month of the year so that there is no dry season, just green grass and flowers all summer and green grass all winter, for North Island is in a relatively warm climate extending from 34 to 42 degrees south. This compares with the California coast from the Oregon line south to Los Angeles so far as latitude is concerned, but otherwise it is very different. The rainfall is quite uniform over the whole of North Island because the great bulk of the area is a tableland about 1,000 feet high with no range of mountains to produce a wet and dry side; only a few scattered volcanic peaks which

have no more than a local "rain shadow" effect.

With this sort of climate the natural trend was toward the raising of livestock. Nobody appears to have to work in New Zealand, at least in the country. One can ride the bus or drive all day and scarcely see a single farmer at work in the fields. Cutting hay is something of a risk because the year-round rainfall makes it very difficult to cure hay and besides why bother with hay when the grass is always green? Consequently, the farmer does little but move his sheep from paddock to paddock, being careful to see that they do not overgraze or allow the feed to become too coarse from under grazing. Nearly everyone has a small family orchard and a little plot of ground on which to grow a few vegetables. Other than these small plots, practically all of the land is devoted to grazing, either cattle or sheep, so that the exports of North Island are butter, wool, and frozen meats.

Since all of North Island was once covered with a thick forest, the clearing of the land by the pioneers was really a stupendous undertaking. Some canyons and steep hillsides still retain their native cover and the observant tourist can see at a glance the man-hours which must have been involved. In some places old stumps and logs remain unburned to show the density of the forest, where now, every square foot is covered with clover and grass. I marveled many times at the lack of weeds in the New Zealand pastures. Apparently there were no grasses or clovers or weeds in this thickly forested land and when the New Zealanders imported seed they saw to it that it was pure.

This heaven-on-earth stockman's paradise, where nobody seems to work much any more, appears to be resented to some extent by the city dwellers. Once or twice this subject was brought up by professional men. One, a "barrister" from Christchurch, said the the New Zealand

farmers were a lazy crew who did little more than clip their sheep twice a year. There is not much incentive for hard work, however, because the government, which has long been socialistic, will not allow a citizen to take any considerable amount of money out of the country with the result that travel is pretty well restricted to the homeland or Australia. Also, government ownership of transportation, communications, and public utilities eliminates many small subsidiary businesses. For example, since the government owns all of the railroads, bus lines and local airlines, telegraph and telephone, it might as well run the Tourist Bureau too. Likewise, many of the hotels. The inevitable red tape and lack of interest in the job is everywhere apparent.

The office of the Government Tourist Bureau, where we were to arrange our tour of North Island, was located on the second floor of an old building of about 1880 vintage. Most of the business buildings in Auckland were built between 1880 and 1914. The latest date I saw on any building was an importer's warehouse with a large 1926 over the door. There is, however, considerable residential building under way, although in the style of 30 or 40 years ago.

After making known our desires in the way of a tour we were told that bus tickets were unavailable; we would have to take second-class railroad tickets, and the train did not go near some of the resort areas. All the local citizens, it seemed, were on summer vacation. I had seen the New Zealand trains: They look about as American trains looked in 1880. The freight cars must have been running since 1860--each 42-foot car is covered with canvas and runs on wheels four feet high. Remembering this, we decided to rent a car and were promised a Morris Minor. We were to go from Wellington to Christchurch by air since the steamer was booked solid, according to the Bureau.

January 8, 1959

The report from the Tourist Bureau this morning was that no rental cars were available because they had all been taken by tourists who were in Auckland to see the Grand Prix races. But, we were now told, they had succeeded in getting us bus, hotel, and boat accommodations all the way to Christchurch--this after telling us the day before that the train was the only means of travel available. Starting all over again, we ordered the said accommodations, with the addition of a Morris Minor to be at dockside in Lyttelton (a deepwater harbor about 10 miles over a mountain from Christchurch). Since it was going to take about two hours to make out all the tickets and wire or telephone for confirmations, we had time to go over to the airline and cancel our tickets. We finally boarded the Hamilton bus at 11:45 and after about a hundred stop lights on narrow streets we reached a three-lane highway and headed out into the country. Mrs. Kelly very kindly took charge of the large bundle of tickets and all I had to do was look out the window, take pictures, and try to remember to wind my camera.

This part of North Island is quite thickly settled, with little towns every few miles along the highway. Almost every square foot of the steeply rolling hills was in clover and grass pasture cut up into many small paddocks. Seldom did we see a paddock smaller than five acres and not many over 20 acres in size. Each paddock was separated from the next by a hedge that had overgrown a wire fence. Most hedges were cypress or a kind of cedar and the older ones had grown into large trees. In many places the farmers had used blackberries for hedges along the highway, a double deterrent to trespassers when the berries were ripe.

Sheep were everywhere: There are something like 40 million sheep in the two islands of New Zealand. Beef and dairy cattle are about

evenly divided as to numbers, but most of the beef cattle are raised in South Island and the dairy cattle in North Island. I saw only a very few draft horses and some shetland ponies; the beast of burden in New Zealand is the four-wheeled tractor and most of them are kept in the barns. About once or twice a day we would see a farmer cutting or baling hay--always alfalfa, called lucerne--but alfalfa fields are rare. Farnhouses are small but well kept and large barns like those seen in our middle west are non-existent. Only small woolly sheds are needed to store wool and house the tractor, if there is one.

Small English cars are plentiful, many of them with pickup bodies, but big trucks are in short supply. Since the government owns the railroads trucks are not allowed to compete in hauling most goods; only beer trucks, cattle and sheep trucks, and milk trucks are allowed on the highways, and those only in 1½ ton sizes. This makes the highway maintenance job less costly and eliminates the need for thick concrete pavement.

We were engaged in conversation by a very attractive high-school girl who sat just across the aisle. She was delighted to talk to Americans because her older sister was going to the U. S. on a scholarship the next year. She told us about the "i-biling" the beautiful "lykes" and the "ovis" in the ground. I couldn't understand what "kives" were so she explained that they were "ovis" in the ground. Caves and holes--its remarkable what these people can do to the English language. It is no use trying to overhear conversations on the bus or anywhere else because you can't ask them to repeat two or three times while you figure out what they mean. Our sightseeing tour around Auckland had been spoiled to some extent because the Cockney accent of the driver was not improved by gravel in the loud speaker

nor by the radio he kept going all the while. He was listening to race results and betting odds and we were the losers. Some of the natives on the bus were a little piqued, too, because even they could not understand him much of the time.

Many people in New Zealand and Australia take their yearly vacations by bus or train because many do not own automobiles. Several New Zealanders on the bus apologized to us because of the driver's lack of manners, and they complained bitterly about the socialistic government. Not all New Zealanders by any means belong to the Labor Party. They gripe about government ownership but they have had it so long that it has become an established way of life. There are no wealthy people to take over new developments in communications or other business as has been the case in the United States, so when radio or telegraph or some other new development comes to New Zealand the government takes it over. When competition is eliminated improvement and innovation practically cease. The same old railroad equipment is considered good enough, so the rolling stock has been the same since 1880. The maintenance of the Government Transportation Bureau, its political organization and the jobs it provides are all-important, and because the railroads came first they hold the political power and will not allow private capital to compete with them. New Zealanders are well aware of their plight but there is nothing they can do about it now. We in America should thank our lucky stars that we had our "Robber Barons,"--the Morgans, the Hills, the Vanderbilts, and the Harrimans--who built the railroads and competed so fiercely for the wealth of America. These and a few more big names in steel and mining and in petroleum produced the great fortunes that gave private capital its start over government ownership and paved the way for a competitive system of economic progress that is the envy of the rest of the world.

It is soon apparent to an American tourist that the average New Zealander or Australian knows far more about America than the average American knows about these countries down under. They look to America as the world leader. Their magazine stands are filled with American magazines, which are more numerous than their own or those from Great Britain. In contrast, American information about our English-speaking relatives below the equator comes from our own publications and our own reporters who now and again make quick trips down to New Zealand and Australia.

Bookstores, I must report, are much more prevalent than in the United States and much better patronized. There seem to be plenty of good native authors and books from England and the Continent seem to be more numerous than American works. This may be due to the slower development of radio and TV.

At the end of a long day's travel by bus we arrived at Waitomo, an oldtime resort hotel where the famous Waitomo Caves are located. The hotel was built about 1890 but has been remodeled to some extent and is quite comfortable.

The limestone caves are located in a canyon about 100 yards from the hotel. Two or three guides are provided for as many parties and a charge of two shillings is made at the entrance. The main attraction in this cave is not the stalagmites or stalactites but the fireflies which attach their webs to the roof of the cave and look for all the world like stars in the sky on a very dark night. Water runs through the cave and the tour is made by boat. The guide turns off the electric lights and pulls the boat along by means of a cable attached to the wall of the cave, hand over hand in the pitch blackness. Soon the lights of the fireflies appear in the roof and finally they become so thickly spread over the ceiling that one can see his fellow passengers in the boat, at least in outline, in the

dim glow.

January 9, 1959:

The Tourist Bureau arranged to have us taken over to Rotorua by taxi where we could catch another bus for Wellington. I had quite an interesting conversation with an Australian rice grower who was traveling alone. He had too big a family at home and couldn't afford to take them all so went alone. He said that Australian farmers were following California rice-growing methods and had sent one of their members over to the Sacramento Valley to learn how.

Rotorua is the resort town of the big thermal region that extends in a wide band from north to south in North Island. This thermal strip averages perhaps 10 miles wide and about 150 miles long and seems to be associated with the Toga-Kermadec Islands and their accompanying submarine trenches and volcanics. Its hot springs and geysers are among the most active in the world and are associated with volcanoes and a very active earthquake zone.

These springs and geysers early became famous as a tourist attraction, some of the first hotels in the area having been built about 1880. In 1886 a violent eruption split Mt. Tarawera from end to end and discharged about a cubic mile of volcanic ash and mud which covered the land for miles around. The splendid pink and white terraces which had been the show spots before were submerged by lake waters and many new geysers and boiling springs were produced. In 1901 a giant geyser broke out in this area and remained active for nearly four years. Called Waimangu Geyser, it erupted every 36 hours, continuing for five hours at a time throwing black mud and rock from 1,00 to 1,500 feet into the air. Later, in 1917, the same area (called Frying Pan Flats) blew up again but subsided within a few months to the normal boiling lake and steam vents.

The town of Rotorua is about 15 miles away from this area, across

Lake Rotorua but even here the evidence of heat immediately below is enough to make the tourist a little nervous. In many places around town there are steam vents coming up among the buildings and in the park. Big bath houses have been built for those who wish to "take the waters" and the hotels are fully equipped with natural hot--and cold--water. One of the attractions is Fairy Springs, where a great volume of cold spring water issues out of a volcanic vent and flows down to Lake Rotorua in a large stream. The big rainbow trout come up the stream from the lake to lie in the pool and eat the bread crumbs the tourists throw to them. It is hard on the fisherman to look at these big 20-inch trout and know he can't throw in a line.

Just at the end of the main street, in the midst of geysers and hot springs, is the Maori village which every tourist visits, many of them under the guidance of Rangī, a Maori woman of about 65 who has been a guide at her native village of Whaka for most of her lifetime. She has met and talked with almost every dignitary in the British Empire from the King and Queen on down the line. She has a very caustic wit and is not afraid to say what she thinks to anybody, so her reputation has spread far and wide. There are always a few Maori women washing clothes in the hot pools, kids swimming in the cold creek and diving for pennies, and a few pots of stew cooking over the many steam vents that are everywhere in the village.

We stayed in Brent's Hotel and nearby saw the biggest Sequoia gigantea I have ever seen outside of Sequoia National Park--about six feet through and perhaps 125 feet high. There are many Sequoias in New Zealand.

January 10, 1959:

At 8:15 a.m. we started on the all-day journey by bus to Wellington. Our route lay through a reforested area that had been planted after the big volcanic eruption of 1917 which killed much of the forest in

the region. Most of the timber planted was imported from other lands, much of it from California. Thousands of acres of Monterey pines, Monterey cypresses, and other pines that look like yellow pine have been set out in thickly planted plots, mostly on an eight-by-eight-foot spacing. Many of these trees are now over 100 feet tall and about 18 inches in diameter. In other places five rows of trees were planted on one side of the highway and these extend for miles and miles, with sheep paddocks on either side.

About 10 o'clock we reached Wairakei where the bus stopped for tea. Here is located a giant hot spring and blow hole from which steam at 1,000 pounds per square inch escapes with a roar like a thousand freight trains. It shakes the ground for a quarter of a mile around and produces a plume of steam 1,000 feet high. The steam is so hot that a piece of iron held in it is said to turn red-hot in an instant. It is called the "Safety Valve" of New Zealand and certainly gives the impression of unlimited power. The New Zealand government is now building a power-generating plant about a mile away and four big 24-inch steam lines to carry the steam. The big problem will no doubt be faced when they finally get ready to divert the steam into these pipelines.

A few miles beyond Wairakei is Lake Taupo, the biggest lake on North Island and near its geographical center. It is about 18 miles in diameter and appears to be an old cauldron or subsidence basin. It is quite deep and about two-thirds of the shoreline is made up of nearly sheer walls of volcanic rock. Trout fishing here is said to be as fine as any in the world--all imported fish from northern climes. Beyond the lake we climbed for many miles through a pass between three large volcanoes. The largest, Mt. Ruapehu, is 9,175 feet high and snow-covered.

Beyond the three volcanoes the highway begins a descent toward the southwest coast of the island, first in one river valley and then crossing over a ridge into another. Little towns are scattered along the route,

all with unpronounceable Maori names. Whoever drew the maps and named the towns of New Zealand, was determined they wouldn't sound like those at home in England or Scotland.

As we neared the coast the land became flatter and the river valley wider and I began to see the first signs of Pleistocene gravel deposits. The highway actually never reaches the coast but stays about 10 miles inland, following along a beautiful coastal arc some 80 miles in length which is in turn paralleled by a range of mountains through its southern half. Where the highway first reaches the coastal plain at Wanganui, sand dunes of considerable height can be seen toward the ocean, but further inland and for at least 10 miles before reaching the town of Wanganui, the road cuts across hundreds of low sand dunes that parallel each other in almost straight southeast and northwest lines. They are quite low, few exceeding 15 feet in height, and are perhaps 100 feet in width--all inactive and covered with a growth of scrub trees. They do not follow the gradient of the river valley or the slope of the coastal plain toward the sea but ^{cut} across it an angle of about 45 degrees. The river valley itself shows Pleistocene river terraces of considerable size where it emerges from the hills and as the road continues southwest along the coast where the mountains come down closer to the sea these terraces are even more in evidence.

These dunes extend as far as one can see in either direction from the highway, always parallel and always the same height. They must have been made quickly and then ceased to grow or move, because otherwise they would have grown into tall dunes of the ordinary variety as seen along many coastlines of the world. In fact, ordinary dunes can be seen along the coast, as I mentioned above. These ordinary coastal dunes have been blocked by the thick growth of trees and vegetation on their landward sides, forcing the dunes to grow

higher rather than to move inland. Their growth is now very slow because the beach line has reached a static or near-static condition in which the production of new sand is very slow. All sand dunes along a coastline are due to prevailing winds blowing along the length of the beach. The longer the stretch of coast before the wind cuts inland, the larger the dunes will be, Where onshore winds strike the coast at right angles, few if any dunes are produced, a condition well illustrated along this particular stretch of New Zealand coast. The strange and anomalous inland dunes found in this region of rather high rainfall are enough to make the observant naturalist realize that something went on here in the not-too-distant past that was very different from present conditions. *Impact oceanic flood?*

Here we have one of the paradoxes that must baffle the orthodox geologist. The very wet Pleistocene climate that he envisions as occurring about 10,000 years ago and the one that produced all of the high river terraces and gravel deposits must surely have produced a dense vegetation too. How, one may ask, did sand-dune growth occur in such a wet climate? Signs of both wet and dry climate occurring at the same time in the same locality are somewhat embarrassing to the orthodox geologist and usually go unmentioned in the textbooks.

As we neared Wellington we suddenly came upon the harbor of Plimmerton, a half-scale replica of San Francisco Bay. It has the same outline of shore, the same high surrounding hills, and the same streets and houses ascending to their tops. It is really a residential suburb of Wellington and connected to its big neighbor by a new four-lane highway, one of the few we saw down under. Its beautiful harbor is not much used except as a haven for small craft, because Wellington only 10 miles away on Cook Strait is one of the finest harbors in the world. The south shore of Cook Strait is one vast network of potential harbors as seen in Queen Charlotte Sound,

Marlborough Sound, and Pelorus Sound--literally hundres of miles of protected coastline.

The four-lane highway mentioned above is of interest because it is built on two levels, the inbound lanes being about 10 to 20 feet higher than the joutbound. It proceeds through a narrow canyon that is quite straight along most of the 10 miles, indicating that this is one of the major and paralleling faults that extend across Cook Strait to South Island. There is good evidence, in fact, pointing to the possibility that the north and south island were once joined but that some violent cataclysm tore them asunder, at the same time drifting North Island a little to the east. The paralleling canyons and mountain ridges of North Island almost line up with a like set of canyons and ridges on South Island:

Our bus came to a stop at a downtown terminal only a few blocks from the dock where the steamer (ferry) to Christchurch was loading. We were soon aboard the ship, a sizeable steamer about 500 feet long that carried about 60 automobiles on two stern decks. This steamship ferry is the main connecting link between North Island and South Island and the railroad lines of North Island terminate at the dock alongside the ferry. We sailed at 8:00 p.m. just as the lights were coming on and the sunset colors were fading into darkness.

Wellington is a beautiful city, its main business district close to the docks and many business buildings ascending the steep hillside which rises almost directly from the shoreline, leaving little flat area for large buildings. The streets are quite narrow and most of the local transportation is by interurban electric train. We did not get to see any of the residential area or the surrounding country by bus or taxi because of our schedule, but the steamer trip out through the harbor provides a very good idea of the size and spread of the city:

The hills are quite high around the harbor and descend steeply

to the water indicating that the water is deep close in to shore. The docking area now in use appears to be about a mile long but certainly covers no more than 5 per cent of the shoreline available for future development, for there are many points and indentations around this nearly circular harbor which is about six to seven miles across. Residential areas have been established all around the harbor and the lights from these dwellings and the brighter glow from the city itself is a sight I shall long remember.

A brisk breeze was blowing as we passed out between the rock bluffs at the harbor entrance and into Cook Strait. The sea gulls which had been following the ship for garbage and tidbits tossed into the air by passengers began to drop away one by one because it was getting dark and time to go to roost. Soon the ship began to roll and we knew we were getting out into the Strait and perhaps a little rough weather ahead.

CHAPTER V

NEW ZEALAND--SOUTH ISLAND

January 11, 1959:

We were awakened by the ship's whistle and were soon up and standing at the rail, at 6:30 a.m. We were entering the port of Lyttelton which is a deep gash in Banks Peninsula, a 1,500-foot mountain that is buttoned on to the otherwise flat coastal plain. This peninsular mountain is about 30 miles long and nearly as wide and is cut into many fiord-like inlets, one of which is called Port Lyttelton. This is the harbor for Christchurch, a city of about 200,000 which lies inland about 10 miles and about 10 miles north of the port of Lyttelton. We were met at the dock by a very nice gentleman from the car-rental agency in Christchurch and our experiences in South Island began.

After piling all of our baggage into the little Morris Minor, the gentlemen from Christchurch suggested that I drive so that he could observe my ability to do so on the way over the mountain to the city. The road proved to be very crooked and steep, rising about 1,000 feet over the mountain and down the other side to the plain on which the city of Christchurch is located. I made it all right, but not without fear and trembling. Driving on the wrong side of the road is bad enough, but shifting gears with the left hand and moving one's foot in the opposite direction from throttle to break pedal is even more nerve wracking. Being Sunday morning and early, the town was quite dead and traffic was not a problem, so we managed to get to the agency office without incident. There it came to light that I had no New Zealand driver's license and that my American one would not

suffice. It being Sunday, there was no chance to get one. At first our agent said we would have to stay over until Monday in order to get a license, but when we reminded him that all our hotel reservations had been made, he reconsidered and advised us to drive carefully.

We started out of town, south and along the east coast. My directions were backwards from the start and we were soon thoroughly lost. Anyone who thinks he has a good sense of direction should travel in the southern hemisphere to break himself of that conceit. During the summer season the sun is north of the Zenith. It rises south of due east and sets to the south of due west--just the opposite of what one is used to in the northern hemisphere. This throws one's sense of direction for a complete loop. You find yourself continually fighting to keep your directions straight and except for morning and evening when the sun is low in the sky it is nearly impossible. Until a person has this experience he doesn't realize that sense of direction is just as real and as continuous as the sense of hearing or sight. Even in sleep a person maintains his sense of direction. He knows where north or south is and goes to bed, sleeps, dreams and awakens without ever losing that sense of direction. The position of the sun is important in all this. Having been born and raised in the northern hemisphere, the northerner instinctively knows that the sun is always to the south of him at midday. When he goes to the southern hemisphere his instinct goes right on telling his subconscious mind that the sun is to the south, and so his sense of direction is reversed.

Added to all this, I was born on the Pacific coast of North American and when I travel along the coast with the ocean on my left I know automatically that I am going in a northerly direction. On the east coast of New Zealand, however, finding the ocean on your left means that you are going south (actually southeast), but my sense of direction was still tuned to the California coast and would

have none of it.

*from Wellington
to Christchurch*

We found that the 200 miles between Wellington and Christchurch had made a very marked difference in climate. The whole picture changed. Yellow grain fields and brown hills had replaced the green hills of North Island and far to the west high, rough mountains loomed on the horizon. The grain fields were large, most of them well over 100 acres, and many looked like full sections. All had been harvested or left fallow and many were bordered with Eucalyptus trees, probably for wind breaks.

The coastal plain at Christchurch is about 30 miles wide but it gradually narrows finally disappearing where the coastline meets the foothills of the mountains at Temuka, about 100 miles to the south of Christchurch. We crossed a number of large rivers and finally reached the Waitaki River which is the largest on the east coast. It heads in the great Tasman Glacier (pronounced glasser, down under) and its tributaries drain three large mountain lakes so that it is really a large stream of water. Near the coast where we first saw its milky green glacial waters, it was at least a half-mile wide and 10 or 15 feet deep, a river not to be depreciated in any land. We traveled inland along this river for about 60 miles to where the road forked. The north fork went to Mt. Cook and its mountain resort town called The Hermitage, but we had to forgo that trip and turned south toward Queenstown.

*Picture of
river*

The mountain scenery had been getting better by the hour and I had stopped many times to take pictures, only to find something much better just around the next turn. The road winds through mountain gorges like the best in Colorado with streams where volume far exceeds those in that state--all of this at altitudes that seldom exceed 1,500 feet. The highest pass in South Island where one may travel by car is only 3,500 feet above sea level. As one travels inland,

the country gets drier and there are some sections where the rainfall is only about 12 inches per year. The rough angular mountains are dark lavas and the black rocks are in great contrast to the yellow grass of the summer season which clothes the mountains from top to bottom. The river valleys in this section remind one of eastern Oregon or eastern Washington along the Columbia River. The hills are dry but the rivers are lined with willows, Lombardy poplars, cottonwoods, and ^{conifers} conifers--all imported from America or other climes. This scenery makes a westerner feel at home. Picture

As we penetrated deeper into the mountains the scenery became even grander and clouds settled in on the peaks so that we could not see the tops. It began to rain, but the road was well graveled and we had no trouble. Some of this road is paved (sealed in New Zealand) but much more of it is only well kept gravel; but the little Morris Minor rolled up most of the grades in fourth gear. I was amazed at the speed and power of this little 10-horsepower car. It had a governor on it to prevent driving over 50 miles per hour, but it would actually do about 53 on level road. At 55 it would start missing just as if the gasoline were running out and would actually cut out altogether if you held the foot throttle on the floor. The governor was evidently installed for benefit of the tourist trade as New Zealanders are a very law-abiding people and very few exceed the legal speed limit of 50 miles per hour. Hotel rooms are never locked by local people and many hotels do not bother to give guests keys to their rooms. Some even charge a deposit for a key if it is asked for because they say the tourists carry them off and it costs money to replace them.

As we neared Queenstown the scenery really became exotic. I was stopping every few hundred yards to look and take more pictures. Queenstown is at the corner of Lake Wakatipu, a beautiful Z-shaped

lake that is 52 miles long and over 1,200 feet deep. The lake is narrow, from three to five miles in width, and its surface is only 1,000 feet above sea level so that the wild rugged mountains which rise directly from the shoreline look even higher than they actually are 7,000 to 9,000 feet. To the east of Queenstown the lake is bordered by a range called the Remarkables and they are indeed remarkable with turrets and spires and deep canyons and cliffs, all bathed in wisps of cloud and sunshine. There was even a little snow here and there, though we saw them in the summertime.

The lower shoulders of the mountains along Lake Wakatipu are quite smooth for they have been well glaciated up to a distance of about 1,500 feet above the lake level. One granite knob in the middle of the valley near Queenstown took the full power of the ice. It is only about 800 feet high but rounded and polished so that not a single jagged rock protrudes, and the direction of ice movement is well recorded in the grooves and gouges along its sides. Nowhere have I seen glacial action more clearly defined.

The present outlet of the lake is near Queenstown where a bridge was built across the opening and a dam with concrete gates built beneath so that the level of the lake could be controlled. However, it has never been used to raise the lake level but only as a hard bottom to keep the channel from cutting deeper and lowering the level of the lake for this outlet is dammed by an old glacial moraine that would cut away in time. The outlet gate is only about 900 feet wide but the crystal clear water moving over the gate in a low water fall is probably ten feet deep. To a southern Californian, such a volume of clear snow water is hard to believe.

Below the dam, the Kawarau River flows down a very spectacular mountain gorge to the town of Cromwell where it joins another river

of equally large size, the Lindis, which drains two other large lakes, Lake Hawea and Lake Wanaka. From Cromwell down to the sea it is called the Clutha, a river that I should guess, carries more water than the Colorado. It enters the sea at a small town called Balclutha.

Ponder a moment with the writer, this great lake at Queenstown. Lake Wakatipu was once filled with 1500 feet of glacial ice and the river which discharged the meltwater, flowed out at Kingston and down the Mataura River, entering the sea nearly a hundred miles south of Balclutha. What happened when all this ice melted and why did the meltwater change its course and flow out thru the Kawarau?

These are questions that might be answered in several ways by the orthodox geologist and the usual method is to make everything fit the accepted theory and ignore or fail to see any anomalies that cannot be explained. For example, the only reference I was able to find was in a text book by Dr. C. A. Cotton, professor of geology at Victoria University, Wellington, New Zealand. He states: "The size of most large lakes in New Zealand--e.g., Wakatipu and Taupo,--has clearly been reduced by filling and lowering of the outlet." This is certainly true, and especially since the close of the "Ice Ages" but what about the old outlet at Kingston thru the Mataura River. What about the plain glacial evidence that the ice once stood 1500 feet above the present lake level. He sees this glacial evidence and points out that the ice was once piled deep in this glacial valley gouging out the lake bed 1242 feet deep, the bottom being 227 feet below sea level, but like all orthodox geologists he has no explanation for the great accumulation of Pleistocene ice or why it melted so quickly. In typical fashion, he overlooks the anomalies and gives the natural wonder a name. Because these lakes are at the foot of mountains (he cites other similar ones in the Italian Alps and in Scotland)--They

are therefore termed piedmont lakes." The word Piedmont is the name of a section of northern Italy lying at the foot of the Alps. Turin is the capital city. Hence any geological formation at the foot of a mountain including a lake can be called a piedmont. This is the modern scientific method.

Map of N. I. C.
& old S. I. C.

Our explanation of what happened at Lake Wakatipu some ten or eleven thousand years ago is a good deal more complicated than Dr. Cotton's. When huge glaciers filled all of the valleys of South Island, this area was only 800 miles from the old Antarctic circle. Now it is 1400 miles from the present Antarctic circle. This made for a much greater snow accumulation in a naturally wet climate. The greatest ice accumulation in the northern hemisphere, other than Greenland, is in the first 800 miles south of the Arctic circle along the Alaskan and Canadian Pacific Coast. Farther south, the high precipitation turns to rain. So South Island was in a fine location for high accumulation of glacial ice. The great Wakatipu glacier that then filled this valley had pushed a vast volume of rock debris into the turn of the valley where Queenstown now stands. (See Fig. _____.) Another smaller hanging glacier coming down from the northeast and heading in what is now called Lochmager, produced a further damming of the headwaters of the Kawarau River, which was probably no more than a tiny stream. The main meltwater flow of this whole glacial complex drained out through the Mataura River. Here the valley is adequate to take the flow being about two miles wide at Kingston and widening toward the south. The Kawarau River gorge, on the other hand, shows no sign that glacial ice ever passed thru it. It is a typical straight-walled river gorge of V shape with many narrow deep stretches where the walls are verticle cliffs. It does show the evidence that tremendous volumes of flood waters did

picture

pass through this gorge. At one point in the canyon just below the bridge, there is a field of huge boulders that were deposited here on the inside of the turn, and high above, (I estimated three hundred feet,) there are numerous gravel terraces marking the extreme crest of the flood. This particular area in the gorge cannot be more than 800 feet in elevation because the surface of Lake Wakatipu is only 1,000 feet above sea level.

As we have indicated, before the cataclysm changed the prevailing glacial conditions, this great glacier was slowly digging itself into the earth and pushing the rock debris ahead of its snout down the valley past Kingston. During the summer season the meltwater no doubt produced a wide flat flood plain from side to side of the valley, but when the oceanic flood swept in from the south it carried a tremendous load of gravel and other debris that was dumped on the snout of the glacier. Much of the water entering this valley may have swept over the glacier and passed on down the Kawarau River, beginning the job of deepening the gorge. For a time, the meltwater seems to have drained through both rivers because the fossil river channel that winds back and forth across the flat valley floor is no small stream bed. It is about 20 feet deep and about 200 yards wide with steep banks. There is no sign of even a tiny stream bed in its bottom today because being on the top of the divide, (headwaters of the two rivers) and in deep and porous gravel, any rain that does fall is swallowed up at once.

Effects of this last oceanic flood are seen in many places on South Island, some of which we will discuss later, but those of the terminal moraine at Kingston are of especial interest. Unlike most terminal moraines which are inverted V-shaped dams of boulder gravel, this moraine is nearly flat on top and slopes very gently for a distance

*Picture of
could be*

of about ten miles down the valley. There are a few big heaps of boulders right at its crest and on the inner face of the dam that slopes down to the lake, about 400 feet below. There at the foot of the mountain wall and along the lake shore lies Kingston, a little resort town with one street and one hotel. The highway mounts up the steep slope of the moraine and then flattens out in a straight line down the center of the valley. It should hardly be called a vally (perhaps piedmont) because the word valley usually indicates a basin that curves up on the sides to meet the mountain walls. In contrast, this moraine is absolutely flat from side to side and meets the steep mountain walls at a very sharp angle. Its downstream slope is so nearly level that the car would not coast when I threw it out of gear but quickly slowed down to a few miles per hour. At the end of this near level stretch the valley widens and breaks off quite steeply and the little streamlets appear that are the headwaters of this branch of the Mataura River. This old glacial dam is so smooth, and level on top, from side to side, that it reminds one of some gently sloping beach made by tidal waters that have flowed back and forth for ages. One thing seems certain, the water that deposited this vast gravel dam must have filled the valley from side to side several hundred feet deep and then drained off never to return. The fossil river channel did not produce the wide valley fill. It merely carried the meltwater for a few years until the Kawarau had deepened its channel to the point where it could steal the whole production. This was easy to do because the water was cutting through the old glacial moraine that had dammed off the headwaters of the Kawarau River. This old moraine is much in evidence, the local airstrip and part of the city of Queenstown is built on its smoothly contoured surface and where the river cuts thru it, a 200 foot thick section exposes everything from boulders to fine clay.

*Picture
Looking
Down*

Queenstown

We arrived in Queenstown about sundown, found our hotel, and began to enjoy some of the most remarkable and beautiful mountain-lake scenery to be found anywhere in the world. World travelers agree: Here is "Shangra La". Far away from the "howling mobs" of the northern hemisphere, it remains unspoiled--a beautiful, quiet little town (perhaps 1,500 or 2,000 people) around a cove in the lake shore with a little wharf and a sandy beach where people can swim in reasonably warm water. Remember, it is only 1,000 feet above sea level and the climate is quite mild. Only on rare occasions, we were told, does the winter snow get down to the level of the town, but the towering wall of mountains is covered with a thick blanket through much of the year.

The tourists go out on the little wharf to scatter crumbs for the big trout that have grown tame because fishing is not allowed in the cove. Wild ducks too, have learned of this bonanza, and have come to compete with the trout. I saw a pair of big moray eels under the wharf and was told that they come up the river in the spring and are quite a nuisance to the fishermen because they scare away the trout and get themselves caught and break up the fishermen's gear.

January 12, 1959:

We were up early to a good breakfast of bacon and eggs, but not the kind of bacon we have in the U.S.A. Down under, the bacon comes from down under the hog. We would call it third-grade bacon, or the uncouth pioneer expression,--"sowbelly".

Food prices here, we found, were not very different from those at home. Everything is higher in these mountain resorts because of the freight cost in hauling it there. Gasoline was 80 cents a British Imperial gallon and the only service the attendant performs is the job of pumping the petrol into the glass container at the top of the pump and then watching it run into your tank. The rest rooms, you are told, are down the street at the hotel, if you don't mind asking.

We started off at 8:00 A.M. on a loop sightseeing trip, beginning with a return trip down the Kawarau River gorge that we had come up the evening before. It was just as interesting, however, seeing it in reverse, and besides, I wanted to take more pictures of flood evidence and earthquake faults in the morning light. At one point, on the inside of a turn in the canyon, there is a huge deposit of boulder gravel, some of the individual boulders being as large as small houses. Also at this point there are old sand bars that mark the highwater level when the glacial discharge was at its peak. These look to be about 300 feet above the present level of the river and indicate a flow (in second feet) that must have been a thousand times as great as present flood stages.

A little farther down the gorge a recent earthquake has produced a fault scarp of unusual size and straightness. In several places displacements of about 15 feet are seen, the straight line of the fault slicing through the bends in the canyon where sand and gravel deposits have accumulated. Some of these very recent gravel deposits are standing as perpendicular walls, indicating that the earth shock that produced them must have occurred only a few years before, otherwise local rainfall would have cut down these soft sand banks.

Arriving at Cromwell, we turned back up the north fork of the Clutha by way of Queensbury to the other two big mountain lakes of this vicinity. The larger of the two, Lake Wanaka, is about 30 miles long and 8 to 10 miles wide. Just over a mountain ridge is Lake Hawea, about half as large. Like all the other lake basins on South Island, these lakes were once filled with big glaciers and each has its huge terminal moraine that forms the dam at the foot of the lake. One of the glacial features that seem to be lacking in most of these glaciated lakes is the lateral moraine. We drove for several miles along the west shore of Lake Wanaka without seeing any sign of glacial debris,

Only polished granite side walls of the mountain that formed the western shore of the lake.

On our way back to Queenstown, we took a narrow, less-traveled road which goes by way of the old mining town of Cardsona. We drove past beautiful farms with green fields of alfalfa, big groves of weeping willows along the river and Lombardy poplars around the farm houses. Beef cattle were everywhere and I was later told that the biggest cattle ranch on South Island is located at Lake Wanaka and that they run 17,000 head of cattle on less than 17,000 acres of land. This I can believe, for this area contains some of the most beautiful mountain pastures I have ever seen.

Our road traversed a series of narrow canyons all pointing south-- up to the headwaters of one and down the next in a sort of roller-coaster fashion--until we reached the high pass overlooking the Queenstown valley. This pass at 3,660 feet is the highest roadway in New Zealand. The road descends in a zig-zag course down a very steep mountain 2,600 feet to the valley farms below. It is a grand and spectacular view *picture* from this pass across the alpine peaks of New Zealand. I looked carefully for any sign of oceanic flood gravel in this pass but found nothing but hard schists. This would indicate that the oceanic flood waters never reached the heights here that they did in North America. In all of the big open valleys at elevations below 1,200 feet, there are vast gravel bars and river terraces indicating water flow many thousands of times as great as any that could possibly flow there now. As one proceeds inland from the east coast the lava mountains give way to ridges of softer schist that dip steeply toward the east. The schists are inter-bedded with softer shales which have eroded away to form the valleys between. Perhaps this existence of softer rocks allowed the glaciers to cut much deeper than is usually the case so that many of the big lakes have their bottoms below sea level. This fact, and the fact

that there was no steep gradient to the sea, caused the inland glaciers to remain fixed in their beds when the shift in polar axis of the earth took place. One of the interesting facts about these big valley glaciers is the almost complete lack of lateral moraines along the shores. I don't know why this should be unless all the rock debris of the lateral moraines is below lake level. Here, as in our Great Lakes of North America, the thick toe in the lakes was last to melt. At first, with the great weight of ice and little if any water, the ice rested on the bottom, but finally, when enough ice had melted off the top, the giant berg would float in its basin and keep its head above water. In our own Great Lakes, at about the same elevation, the flood waters first carried away the thin edges and then filled in against the remaining thick ice with sediments, piled highest against the ice. As the ice melted back, this higher ridge of sediments became the shoreline so that now we have the unusual condition of a large body of water with streams heading at its very shoreline and running away to the south.

January 13, 1959:

We ordered an early breakfast (7:30) and got away at eight o'clock for the southern lake country which is on the road to Milford Sound. The early morning mists were breaking away from the mountains and the patches of sunshine on the yellow grain fields against the blue of the mountains and the deeper blue of the lake, and the dark green of pines and Lombardy poplars, made a sight that I shall never forget.

What sets Queenstown apart from other mountain resorts I have seen is the peaceful farm-home setting: The tall, graceful poplar *picture* bending in the wind, the stiff-backed pines around the red-roofed farm houses; the family orchards and flower gardens; the green alfalfa fields mixed in with the yellow of the ripening grain and the cattle and sheep feeding in the pastures. A man came galloping down the road

toward us, riding bareback and carrying a shovel over one shoulder. Probably a neighbor had phoned to say that his irrigation ditch had broken and he had not taken time to saddle his horse or put on a hat. If only I had had time to take a picture of this rider, dark against the morning mist and sunlight, with back drop of fields, mountains and lake.

We were traveling along the south arm of Lake Wakatipu toward Kingston. The road seldom gets more than a hundred feet above the shore and the view across the lake to the high mountains beyond is ever-changing and always beautiful. We saw the tourist steamer making its way down the lake on its daily cruise. I stopped several times to take pictures of the Remarkables with their many high peaks peering thru the clouds. It always seems to me that mountains look twice as high and twice as mysterious when enshrouding clouds break away for a few moments and the high summits appear. A flock of geese stood in an alfalfa field but were too far way for a good picture. Its always a temptation to take this kind of pictures. Later, in showing it to your friends, you get to your feet, go to the screen and point out those grey dots that was the biggest buch of geese you ever saw.

*Pictures and
yucca*

Pictures

Most of the mountain sides around the lake are covered with a large bunch grass that is called tussock grass. It grows in heads about 12 to 18 inches in diameter and perhaps twice as tall when the seed stalks develop. Since we were there in the dry summer season, the grass had turned a golden color and was very beautiful in the late afternoon sun. It is not a very good pasture, we were told, because it is so coarse but the sheep men do use it for their high spring pastures. It also provides a good sub-surface for skiing in the winter, being much less dangerous than hidden rocks or tree stumps.

The timber on these mountains is very sparse and not to be compared to our North American forests.

We reached Lake Manapouri at noon after traveling through some pretty dismal swamp country where many thousands of acres of brushland had been sprayed with some chemical to kill the brush. This area was being opened for farm reclamation. It is government land which can be "taken up" as farmland by the citizen who will live on it and develop it. The brush was a dead dark brown color and not very beautiful.

Lake Manapouri is considered to be New Zealand's most beautiful lake, according to the tourist bureau, but we thought otherwise. It is only 500 feet above sea level and, except at the north end, the mountains surrounding it are not high. The adjacent rain forests are very dense and overhang the shore in many places, while the water itself is so filled with vegetable matter that it has a color similar to very weak tea. The road reaches the lake at its lower end where it cuts through the usual morainal dam in a deep quiet river almost as smooth as glass. Many pleasure boats were tied along the shore or anchored along a bend in the river and there was one store, a public camp ground and, I think, a hotel somewhere nearby though we didn't see it. We were told that it was possible to go down the river to the ocean in a shallow draft boat but not easy to come back up because the river widens out into many shallow channels and flows more swiftly as it nears the head of Dusky Sound.

The waters of Lake Te Anau also drain into Manapouri through a narrow canyon about five miles long with a drop of 90 feet in elevation. Those who like to live dangerously shoot the rapids through this canyon. Our road followed around the east shore of Manapouri some distance back in the scrub forest and nothing much of interest was seen until we suddenly emerged on the shore of Lake Te Anau.

Here we found a little town and a resort hotel called Te Anau where we engaged rooms. It was still early in the afternoon so while

Mrs. Kelly did some much needed washing and ironing I went down to the dock and talked with the captain of a tourist fishing boat. After a bit, two New Zealanders came along and the four of us discussed hunting and fishing and politics for about two hours. The captain told us that deer were very numerous and quite a pest so that two government deer "cullers" had been kept busy killing deer for more than five years. A year-long contest between them had resulted in each killing more than 1,200 deer, with the winner, as I remember, holding the record of 1,238. If the "cullers" culled deer 300 days out of the year this would require more than four deer a day--a pretty good deer story in any land.

The captain had taken three deer hunters across the lake a few weeks before for a week's deer hunt on top of the mountain. He pointed the place out to us--open grassland at the top of the mountain across the lake. This mountain is about 2,500 feet high and the top 500 feet is covered with a coarse grass from four to five feet high. The remaining 2,000 feet of steep mountainside down to the lake shore is covered with a rain forest so dense that a hunter must hack his way through with a machete. The captain had started his hunters up a rock creek bed and they did the rest. He said that they only got seven deer because it rained most of the time and they couldn't see the deer anyway, the grass was so high. The way to hunt deer up there, he allowed, was to roll a big boulder down the mountain through the tall grass and when the bucks started jumping, shoot 'em on the wing. I asked him how much he thought it rained on the mountaintop and he thought maybe 100 inches a year.

Back to the hotel for dinner where I heard about an evening boat ride across the lake to the Te Anau Caves. Mrs. Kelly did not wish to go so I grabbed my raincoat and hurried down to the dock. We sailed at sundown and started eastward up the lake just as the nearly full

moon was rising.

Lake Te Anau is the largest lake in New Zealand, although only a little larger than Lake Wakatipu and two or three others, and like all the other glacial lakes it is very deep, the bottom being nearly 350 feet below sea level. The east shore of the lake is relatively straight and slopes away quite gradually, but the west shore is made up of four big fiord-like arms that extend back 10 to 14 miles into the high mountains of the western coast range. These arms of the lake are indeed picturesque, with very steep forest-covered walls and snow peaks at their heads. With a suitable boat and provisions for about two weeks, one could really explore the 200 miles of shoreline, with plenty of trout and venison for the campfire cookouts along the way. (See Fig. _____.)

Map

As we left the dock and began to pull out from the shore, I was struck by the stair case regularity of the old lake shore terraces along the east shore of the lake. (See Fig. _____.) They are six in number, if you count the highest one which has an irregular top line. The second one has a beautiful flat top line and is cut off at the south in a steep slope like the end of a delta. The other five below, down to No. 1 on the lake shore, are graduated in size but altogether are not much greater in height than the big number 5 terrace. As one progresses up the lake these Pleistocene terraces separate into tongues that meet the lake shore at an angle pointing downstream. Each tongue is separated from its neighbor by a good-sized creek. Apparently when the ocean flood water came in over this comparatively low land it carried plenty of gravel. The top two terraces represent the first onrush of water carrying the top gravel deposits to an uneven height, according to the topography. As it came to a stop, it dropped its heavier elements and then started back to the sea with increasing momentum, smoothing out the big number two terrace in a wide even line. Succeeding and returning waves produced the next five terraces, each

a little smaller than the last. The solid mass of glacial ice that filled the lake resisted this onslaught of water and the steep mountain wall on the west side of the glacier could not retain terraces so they were swept smooth. Whatever gravel settled into the crevasses of the glacier sank to the bottom when the ice melted. The total height of these terraces above the lake I would estimate at about 500 feet with the first and second terraces (from top) representing about two-thirds of the total height.

After a boat ride of about two hours we arrived at a little pier where all hands went ashore. Somebody started a gasoline light plant generator and we followed its string of lights through a thick beach forest for about 100 yards to the entrance of the cave. We entered one by one, having to stoop over until we could touch the floor with our hands. Inside the roof was higher and we followed the guide up stairways and around corners until we reached what turned out to be a boat landing. A big stream of water runs through the cave, which it enters a short way up the mountainside. There are many whirlpools and waterfalls and it is necessary to shout in order to make ones self heard. The boat took about a dozen passengers down a corridor while the rest waited their turn. We then climbed another stairway and walked through more passages before getting back to the stream again where we embarked a second time for the final boat ride. This last big cavern is about 300 feet long, 30 feet wide and perhaps 15 feet to the ceiling. Along one wall a rope has been attached to iron spikes driven in the limestone, and as in the Waitomo Caves of North Island, the guide pulls the boat along by means of this rope. Lanterns and flash lights of all kinds must be shut off and the guide admonishes everyone to keep silent because the light of a match or any unusual noise will cause the glow worms to turn their lights off too. Soon the whole roof of the cave was seen to be lighted with thousands of tiny lights spaced hardly more than an inch apart. The glow worm's light pulsates to a tiny degree, giving

the effect of stars twinkling on a dark night.

On the return boat trip down the lake, the crew served tea and biscuits, and some young folks gathered around a ukulele played by a Maori college boy and sang songs while the wind whipped up a good set of whitecaps to glisten in the moonlight.

January 14, 1959:

We headed for Milford Sound about 8:00 a.m. with the sun shining and white clouds floating about the mountains. The road begins to climb soon after it leaves the village of Te Anau but continues along the lake for some sixteen miles before it turns inland and up the Eglinton River valley. This shoreline drive is one of spectacular views across the lake to the three big fiords that push back into the high mountains in Yosemite-like canyons.

The Eglinton River flows through a narrow glacial valley sometimes called Canyon Valley. It is a tree lined mountain valley with a series of open grass meadows along the way and thick beech forests mounting the walls of the valley on either side. We stopped at a place where some very large beech trees were growing on the edge of a meadow in the deep soil of the valley floor. They were huge trees and formed a dense shade. I went in among them and took some pictures back toward the summit meadow. There was much old down timber, moss and leaf mold but no green plants growing in this deep shade. Farther up the valley the road passes through some of the finest beech timber in New Zealand. Here the rainfall is much greater and the underbrush and ferns is as dense as jungle growth. Many trees in this area are tall and straight, with trunks of 6 to 7 feet in diameter and perhaps 150 feet tall. At many points along this road one catches glimpses of the high snow peaks of the western range that peer over the dark forested rim of the valley.

Milford
Sound

picture

picture

picture

Near the headwaters of the Eglinton River the road passes by three small glacial formed lakes that are now surrounded by dense beech forests. From here the road passes over a low divide and into the headwaters of the Hollyford River which it ascends for a few miles to the entrance mouth of Homer Tunnel. This last few miles is very spectacular alpine country. The trees are left behind and granite cliffs take their place, rising sheer for a thousand feet or more in many places, with water falls pouring over the cliffs from the snow fields and small glaciers above.

picture

picture

We had to wait for awhile at the portal of the tunnel for the last outbound cars to come through. A sign warns the traveler that he may not enter the tunnel until 10:35 a.m. and all outbound travelers must be through the tunnel by that time or wait until 3:00 p.m. It is a downhill tunnel with a 10 per cent grade toward the Sound, and is quite rough in spots because there is considerable water running and the inevitable ditches are cut across the gravel roadbed that was laid on the solid rock. In one place a small river leaks through the roof of the tunnel. It is a little frightening to hear all this water rumbling down over a bit of tin roofing.

On emerging from the west portal of the tunnel, one enters a new world. Here it rains as much as 300 inches a year and the growth is truly jungle-like and tropical, even though it is 46 degrees south of the equator. The latitude of Milford Sound could be compared to that of the Columbia River on the Pacific coast or to Nova Scotia on the Atlantic coast--but how different the climates! Here tree ferns and glaciers come down to salt water together, the only place in the world where this occurs. The two islands of New Zealand, if placed in the same latitude north as they are south, would extend from Portland, Oregon, to Los Angeles, California.

The mountain grade down the canyon from the western end of the tunnel is very steep (requiring low gear either up or down) and quite narrow. Running water can be heard everywhere--from the cliffs, from the torrents below, and even dripping from the trees. Melting snow was the main cause of this when we were there, for we were fortunate in having relatively clear weather. But even so it was alternately raining and clearing every few minutes. picture

We stopped at a place half-way down the grade called "The Chasm" which is a deep narrow gorge and waterfall combined, where the river breaks through a hard sandstone ledge. A good trail leads about 150 yards through the forest to a bridge over the chasm. This trail is lined with giant tree ferns and a host of smaller ferns; Katherine counted seven different varieties in one spot. The beech trees were very beautiful, too. In the fog and mist many of these giant trees loomed black against the sky, their scarred branches and feathery foliage reminding one of the trees so often seen in Japanese prints. picture

We reached the hotel at the head of Milford Sound about 11:30 and found our accommodations waiting for us. This was one of the best and most modern hotels we found anywhere on our trip. The old hotel had burned three years before and the tourist bureau had built a new and modern one. Every room had a bath and a picture window looking out over the sound to the magnificent mountains beyond. The meals and other accommodations were excellent and our only sorrow was that we could not stay a full week. Surely there is no more beautiful place in the world than Milford Sound. Sitting in easy chairs by the window, we could look out on a green lawn, a colorful flower garden beneath a giant beech, and beyond, the deep blue waters of the sound with the fairyland mountains rising sheer from the water's edge.

Milford Sound is a fiord about 10 miles long extending back into the mountains which rise directly from the coast. It varies in width from two to three miles but looks much narrower because of the sheer mountain walls on each side which seem almost to overhang the water. The gigantic glacier that once filled this mountain canyon and its tributaries gouged out the hard rock to a depth of 1,800 feet below sea level at the head of the sound and carried the rock debris out to the mouth of the sound where it left it in a terminal moraine that rises to within 250 feet of the surface. Since glaciers build U-shaped valleys with nearly vertical sides, the water of the sound is almost as deep right against the shore as it is out in the center with the result that ships cannot find bottom to anchor in Milford Sound. There is one small cove, called Harrison Cove, where small and medium-size boats can anchor. This is at the foot of Penbrooke Peak, 6,710 feet in elevation, which carries Penbrooke Glacier near its summit. This glacier has ground up the rock and produced the fine sediments that fill Harrison Cove and thus produced a small anchorage. Several of the big world-cruise tourist ships are now coming into Milford Sound each year but they cannot anchor to allow the tourists to go ashore. In time this will no doubt be remedied by docks along the shore at the head of the sound where the land at the mouths of the entering glacial valleys is flat.

January 15, 1959:

We were up early to see the morning mists break away to a very beautiful day. At 9:00 a.m. we were down at the boat dock ready for the boat trip down the sound and back. It was here that we saw the fruit pigeons and the pull-the-cork bird. The latter, a bird about the size of a dove, has a song t^t which sounds like the act of pulling

a cork out of a bottle and then allowing the liquid to gurgle out into the punch bowl. The boat landing is at a tiny cove about a half-mile around the edge of the sound from the hotel and everyone must walk because there is no place to park a car at the dock. Mrs. Kelly's knee was not working well, so I drove her to the dock and then returned to the hotel to park the car. I then joined her on the dock and we fought sand flies until the boat was ready to depart.

It seems that even in this paradise there must be at least one evil thing--the sand fly. The whole history of Milford Sound is interspersed with stories about the sand flies. They are extremely small and bite like little devils. They are in your eyes, ears, and nose, and bite your ankles constantly. At first you think the other tourists are waving at you with their handkerchiefs, but you soon find that they are only fighting the sand flies. The only place one is safe from them is in the hotel or out on the sound in a boat.

The boat ride down Milford Sound to the sea is beyond the power of words to describe. Mitre Peak rises on the left 5,560 feet above the deep blue waters of the sound. This is said to be the greatest sheer rise from sea level of any mountain in the world. At first, when the boat leaves the head of the sound, Mitre Peak appears as an acute-angle pyramid, but as you proceed down the sound it is seen to be a long knife-edged ridge. Across from Mitre Peak is Lion Peak, so named because it looks like a large maned lion sitting on its haunches. Above and beyond is Penbrooke Peak with its glacier, and snow fields on the more distant peaks. The boat proceeds down the south side of the fjord and returns along the other shore.

In some places sheer cliffs over 800 feet high actually overhang the water but mostly the walls of the fiord rise at an angle of

about 75 to 80 degrees and are covered with ferns and trees and other vegetation of many kinds. When the trees and other vegetation grow to a certain size, the dead weight is such that the roots can no longer stand the strain; then snow or misty rain adds the weight that starts a landslide and down it goes into the waters of the sound, leaving a narrow white scar on the rock. In a little while nature starts to cover the scar with moss and lichens which take hold on the rock. Then ferns get rooted in the moss and finally shrubs and trees begin to grow and the cycle repeats itself. The effects of these landslides, which might better be called plant slides, can be seen in all stages of the cycle from bare rock to grown tree cover.

There are five good-sized waterfalls along the shores of Milford Sound and many hundreds of little streams trickle down the cliffs until a sudden rainstorm turns them into leaping waterfalls. We were told that on clear days immediately following heavy rains that the falls are really spectacular. At one point the captain brought the boat right up to the cliff, telling us over the loud speaker that we were looking up a sheer 1,000 foot cliff while below us was over 1,000 feet of water. *picture*

A little way beyond the boat landing (about a quarter of a mile) a large waterfall leaps over the cliff from about 500 feet above where a hanging glacier once pushed its debris into the mass of the main glacier. At the foot of this cliff in front of the waterfall is a little rock delta that is now covered with trees and all manner of ferns and grasses. The walk around the foot of the cliff and across this little delta to the foot of the falls is one never to be forgotten. The mist from the falls is continual, even when the rainfall in this super-wet climate ceases for a few days, and the result is a hothouse-like fernery that is truly exotic. The trail proceeds through

trees and tree ferns until the mist becomes so intense that the larger plants can no longer stand it and they give way to swamp plants which normally grow with their roots and leaves in water, but here they grow on granite boulders saturated continuously with rain and mist from the falls.

The wind came up as we returned up the sound and the captain told us we had been very fortunate to have had such a fine sunny morning with the tops of the peaks in view and a smooth trip on the water. Many people, he said, spend two and three weeks at Milford Sound and never see anything but rain and fog.

After dinner (about 8:00 P.M.) I went for a ride in a light plane which makes an evening trip up the valley to Southerland Falls when the weather is good. It was a four-place plane and we had a full load: I got the front seat because I was taking pictures. We had to wait a little while for the other two passengers and I thought to avoid the sand flies by getting into the plane. However, the sand flies had gone to bed on the cockpit floor and they immediately came to life and started chewing on my ankles. The pilot assured me that they much preferred a tender tourist to a tough New Zealander. I was hoping that the late passengers would be a couple of nice-looking girls with tender limbs, but no such luck--only a couple of Australian farmers.

The airstrip points down the sound to catch the prevailing wind but the pilot turned immediately upon being airborne and headed for the cliffs. He explained that the updrafts along the canyon walls make climbing there much easier and so with only one turn around the valley floor he was up about 2,000 feet. He then headed up the main valley toward Southerland Falls, passing in front of five large glacial valleys which enter the main valley from the west. The opposite side of Southerland Valley is just a straight wall without any canyons cutting

back into it, and the bottom of the valley is so nearly level and so little above sea level that the river meanders back and forth in a most fantastic formation of loops. The Milford Track (trail), which comes over the pass from Lake Te Anau, follows down this valley, but it is such a long journey around all of the loops that the usual procedure is to call the hotel and have them send a boat up the river to pick up the less hardy hikers at the rest house.

These glacial valleys are certainly remarkable for uniformity of shape. Each is a perfect U in cross-section and the ridges which separate the valleys are inverted V's, each with almost a knife edge at the top and hardly thicker through at the bottom than they are tall. Four of the five side canyons entering the main valley are carved out to almost the same depth as the main valley and the fifth is a hanging valley that ends in a waterfall jumping over a cliff about 500 feet high. A solid forest covers the floor of all these valleys and each has its meandering stream in the center.

We flew up the west side of the main valley, across the mouths of all these side valleys, and finally reached the head of the main valley where Southerland Falls leaps out of a glacial basin and in three flights descends a vertical distance of 1,904 feet--the highest waterfall in the southern hemisphere and the third highest in the world. It is framed in a perfect setting at the head of this magnificent valley and spills out of a beautiful circular lake (Lake Guill) which fills a glacial cirque, the extensive snowfields beyond providing abundant water for this scenic wonder and making the picture complete.

We returned down the valley at the altitude we had reached over the falls. The pilot said it was poor walking below and he wanted to keep plenty of gliding angle. I had been shooting pictures almost continuously but when I got back to the hotel and examined my camera

a little more closely I found that the film had stuck and that the perforations were stripped so that all my beautiful shots were on the same picture.

January 16, 1959:

We left our pleasant hotel room, its lovely picture window and that magnificent view down Milford Sound, with a certain sadness and regret. Except for the sand flies, the place seemed perfect. We started up the road toward the tunnel about 9:00 a.m., the little car pulling the grade quite easily, most of the way in second gear with only a little low-gear work on the steepest places.

We traveled through the long, dark tunnel and down the mountain on the eastern side, the road looking quite different as we proceeded in the opposite direction. We stopped at the Te Anau store for lunch food and then found a picnic spot along the shore of the lake, but the wind came up and a storm was threatening so we took off for Dunedin with our sandwiches in our hands. We took time, however, for a few more pictures of the very beautifully terraced gravel deposits along the south shore of the lake. These terraces, as I mentioned earlier, are almost as smooth and regular as a staircase, except that each of the first four is a little higher than the last, then the fifth is a big one almost equal in size (depth) to the four below. The top terrace has a reasonably even frontal slope but the top is quite uneven, just a series of gravel mounds that blend into the mountain side which is only a little higher than the gravel terrace at the lower end of the lake. (See Fig. 12.)

The first thought that enters one's mind on seeing these terraces is that they are old shore lines at successive stands of the lake but this cannot be for several reasons. First, because there is no dam at the lower end of the lake that could have held the water necessary

to have made the highest of these terraces. The dam at the lower end of Lake Te Anau is a granite dyke about five miles wide where the glacier poured over and down into Lake Manapouri, which is 90 feet lower. This granite dam is only about fifty feet higher than the lake and the river now cuts through it in a narrow deep gorge. This gorge of the Waiau River is said to be very spectacular and a great place for the daring boatman to shoot the rapids. Part of it is so filled with white water that it is called the Rainbow Reach. In any event, there is no sign of any terminal moraine across the lower end of this lake and only a minor one at the outlet of Lake Manapouri. In general the whole wide valley is open southward to the sea. Second, all of the five terrace levels appear to be the same age. If the level treads of this staircase were evidence of long stands of the lake at these levels, then the upper terraces would show much great erosion. This is not the case.

The surface of Lake Te Anau is less than 600 feet above sea level and its bottom is said to be more than 350 feet below sea level. Dr. Cotton attributes this great depth to "deep gouging by piedmont glaciers a sluggish type common at low levels during the Ice Ages". He does not mention the gravel terraces along the shore of Lake Te Anau, but he does describe South Island as the "land of terraces" and goes on to attribute them to be the work of meandering rivers, and lesser streams.

These old terraces are such an outstanding feature of South Island that they could hardly be missed by a layman who had any interest in the natural landscape. Dr. Cotton in his text book, *ELEMENTS OF GEOMORPHOLOGY*, devotes an entire chapter to "River Terraces and Incised Meanders", and illustrates the text with many fine photographs.* His explanation is strictly orthodox: Starting with an

*See *ELEMENTS OF GEOMORPHOLOGY* pages 240 to 250.

ancient, smoothly eroded land form, (which, of course, he cannot prove ever existed) he has sluggish rivers cutting meander loops across the landscape to the sea as this land is slowly elevated. The gradual elevation causes the rivers to cut (incise) and to form banks that later become the steep slopes of the terraces. Then he requires a long period of drouth or cessation of uplift to produce the flat part of the terrace, followed by another period of uplift and incision,--another cessation of uplift, and so on until the five or six terraces are formed as we now see them. This explanation is in accord with accepted theory but what are the physical facts in the field?

As I have indicated, the upper terraces appear to be just as young as the lower ones and the rugged mountains above them do not indicate great age or an ancient landscape wherein the first and highest terrace could have been made by a meandering river. Many of these river valleys are five or six miles wide with the huge upper terrace following along either side of the valley. Why was the upper terrace always the largest and why do the succeeding lower ones get progressively smaller in height and width? Why is it that the present river in the bottom follows a relatively straight course, without the meandering loops which he says formed the upper terraces? Why is it that the terraces have retained smooth fronts without many indentations from the ends of the loops cutting into their banks? Is there any real proof that a stream so nearly at grade can cut the walls of its valley wider and wider? How about the meandering loops of the San Juan River in Utah or the loops of the Brazos River in Texas? Here deep, narrow, loops have been cut in the hard sandstone with no terraces formed at any stage in the past. How is it that many of these New Zealand terraces are covered with cobblestones two to six inches in diameter when the meandering river alleged to have made them could not possibly

carry anything but the finest silt? In some of the wider valleys, such as the one in which the town of Lunsden is located, this widespread deposit of coarse gravel is very noticeable. The land is very flat, and yet large fields freshly plowed showed that the soil is largely made up of stones from the size of a baseball up to as much as six and eight inches in diameter. The soil is dark in color and the quality of the crops indicate a rich soil, but certainly it would never do for growing potatoes.

This same condition of coarse gravelly soil prevails over a great part of the Canterbury plain south of Christchurch. Here the coastal plain is almost as flat as land can get for 15 to 20 miles inland from the coast, yet it is covered with cobblestones. What ordinary forms of erosion and sedimentation produced these uniform beds of gravel? Certainly not the sluggish rivers that cross these plains now, nor was it by beach erosion and sedimentation! If these rivers could have brought the stones down from the mountains, most would have been deposited near the foothills or along the river channels, not evenly distributed over the wide flood plains between rivers. Only oceanic flood covering the entire coast plain and penetrating far inland to the mountain valleys could have scattered the stones so evenly and produced the terraces and the coastal gravel plains. No amount of uplift or sinking of the land will avail in such a case.

As we traveled across southern New Zealand from Lake Te Anau through Lunsden and Gore to Balclutha, near the south coast, we saw many examples of this terracing and freak gravel deposits. The very large terrace (number five) is only found at elevations around 1,000 feet or a little less, but as we traveled across the river valley, and over the dividing ranges to the next valley we encountered it several times. In one such cross-over we came down a side canyon

into the main valley and in this side canyon we saw a remnant of the big number five terrace. It lined one side of the canyon and appeared to be nearly 200 feet high, very flat on top and of quite fine gravel content. The road followed the other side of the canyon which was just a steep hillside of native rock, and below, a tiny stream meandered back and forth across a flat that was no more than 300 feet wide. This little stream bed was only about 10 feet wide and three or four feet deep, and when running at flood stage it probably filled its channel from bank to bank and perhaps overflowed to cross over the many loops, but when we saw it the water was only a few inches deep. The total length of this little flat was probably less than a half mile, at which point it broke off more steeply down into the main river valley. The other end of the flat ends in the mouth of a small canyon that extends back into a mountain ridge about a mile and perhaps 800 feet higher than the little flat.

Are we to assume that this little stream built a huge gravel bar 200 feet high and over a half-mile long, perfectly flat on top and with a beautifully symmetrical slope? That it did this by meandering back and forth across this narrow flat, leaving all the gravel on one side (the side next to the main river valley) and cleaning the mountain side of its canyon so that no sign of gravel remains there? Obviously this little stream did not produce this huge gravel deposit. The question then arises: Could the main river valley, about five miles wide, have produced these gravel terraces; the upper one about 200 feet high followed by a number of smaller ones? Only at Lake Te Anau did I count 6 terraces. These other higher river valleys do not show all of the terraces at any one location because they are extended along the whole length of

each river valley. Again the answer must be no because the conditions required and the time element involved make it impossible. Let us look at the conditions required.

Remember that the orthodox theory requires an old landscape, an agraded stream looping back and forth across a valley that is so nearly flat the water can scarcely flow. Then a very slow uplifting of the land must begin. The river cutting down to form the terrace slope while at the same time the loops move downstream to grade the whole valley floor from side to side until we have a 200-foot high terrace. Then we must require a cessation of uplift for a considerable period of time and a reduction of river flow of about 75 per cent so that the flat top of the second terrace can be made and vegetation allowed to grow upon it. Then comes the next slow uplift and the cutting of the next lower terrace face followed by another reduction of flow and a second hesitation of uplift and so on for all of the lower terraces. To make these requirements of climatic change and elevation even more impossible, we must realize that these terraces are at a more or less even elevation all around the southeastern end of the island and that they follow the contours in and out of all of the many river valleys. Thus the orthodox theory requires that the land was uplifted in this irregular band all around the island while the coastal plains adjoining were at the same time gently lowered so that the rivers could reach the sea without cutting deep canyons. What the high western mountains were doing at this same time is a moot question. Perhaps tipping like rocking chairs, dumping their glaciers in the ocean and then accumulating more to be dumped again, in a few thousand years. I add this facetious theory by way of showing that it is easy to propose a theory but something else to prove it. Stated in simple homespun language it sounds silly, but dress up the same statement in the jargon of

science and it sounds important.

What orthodox geology does in the case of the so-called river terraces, is offer a theory (based upon a number of assumptions none of which can be proven) as if it was universal and able to fit all conditions. They make no effort to apply their theory to these special terraces, to see if it fits the physical evidence as there found. Apparently they do not pay much attention to the evidence in the field or reason about how nature operated. The trained geologist goes into the field, sees the terraces and knows at once what the book answer is--river terraces made by incised meanders. The only thing left to be done is to make a geological map indicating in pink or green the area covered by said terraces. To start with the present and work back in time, step by step working out all of the fancy physical performances old mother nature would have had to go through to follow out his theory is too much trouble. It is much easier to jump to orthodox conclusions.

We arrived in Dunedin about 5:00 p.m. and were surprised to find such a fine large city. We learned that the population is about 100,000 and that it was settled by the Scotch and still remains mostly Scotch. We saw a few Chinese, who apparently came early in the Gold Rush era.

We registered in another Grand Hotel and parked the car around the next block in an alley. We did get a room with bath, probably one of the few in town, and it was obviously a recent addition. The hotel had been built in the early 1880's when England ruled the seas and there was plenty of money for foreign expansion, especially in the English-speaking colonies. The Stock Exchange Building just across the street had a large 1885 on the front. It was a very ornate building with much cut stone, granite columns, colored windows, iron grill work and other gingerbread that would cost millions to

build now and was not cheap in those days. Judging by the number of fine old buildings, this was a large and important city in 1885, a bigger city than San Diego was, for example, in 1935. In 1885 Dunedin was 50 years ahead of San Diego and now San Diego is nearly that far ahead of Dunedin. Why? Probably the fading of the mother country after World War I and perhaps too much Scotch conservatism.

The dining room in this old hotel was one of the most depressing places I have ever been in. The ceiling was about 20 feet high and it had high windows all along one side covered with venetian blinds that were always closed. Dark and stark and cold and very formal. The elevator only ran as far as the third floor, the fourth and last floor being apparently for second-class guests who had to walk up the last flight of stairs. I walked up in order to look out at window at the top of the stair well and then I found out why they kept the blinds closed on those fine large windows in the dining room. They looked out on the most awful soot-covered, sewerpipe-infested, dirty brick wall you can imagine--the central light well of the building.

January 18, 1959:

After an early breakfast we took the trolley out to the Botanical Gardens where we looked at sequoia trees, ducks, and flower gardens. I spent about 45 minutes writing up my geological notes while Mrs. Kelly walked about these very lovely gardens.

In the afternoon we took a bus tour around the city of Dunedin. I insisted on calling it da-ne-din, to tease Mrs. Kelly and was corrected innumerable times for the infraction of the King's English. (The local people pronounce it da-need-in).

The bus driver told us that some 50 years before an American firm had offered in exchange for a 50-year lease on the harbor, to dredge the harbor and cut a channel out to the south, thus making the east headland into an island. The local authorities refused the offer and they have been dredging the harbor ever since. It

is called Otago Bay and is a long fiord-like channel some 12 miles long and only about a mile to two miles wide. A long ridge that was once an island forms the seaward wall of this harbor. A sand spit closed off the south end of the channel and it is on this sand spit and the low land along the mainland shore that the city has been built. The Americans wanted to cut a harbor channel through this sand spit, a distance of about a half mile. Now the New Zealanders have a continual job of harbor dredging and an additional three miles of channel that must be kept open out to deep water in the mouth of the Fiord. This the driver told us--I suspect, to please the American tourist.

One very interesting thing about this city is the strip park that divides the business section from the residential part of the city. The hills on the mainland side of Otago Bay rise about 300 feet above the waters of the bay and then slope back gently to a tableland. The business and industrial section of the city is built along the waterfront on reclaimed land and on the foot of the hillslope. About half-way up the slope and on its steepest part a narrow band of park, about a city-block wide, forms a buffer strip between the city proper and the residential area. Beautiful, useful--and practical.

We saw in Dunedin the oldest automobiles (in daily use) that we saw anywhere down under. Among others I saw a 1918 Buick like the one my Uncle Matt Kelly once owned. Several old Hupmobiles, an Oakland, a Star, and numerous Model-T Fords. Model-A Fords were common, but later models of American cars are much less numerous than European models.

Our tour included a trip out along the top of the peninsula that forms the eastern side of the Otago Harbor. It is quite high, about 800 feet I should guess, and most of the outer end of it consists of

small farms and sheep paddocks with beautiful green pasture and cypress hedges. High on the very end of the peninsula is the old Scottish castle built by a pioneer Scot who made his fortune in Australian gold fields and spent much of it on this castle. It was started in 1871, took three years to build and 12 years to complete the interior. It cost £125,000 to build. Many of the stones for the towers were brought from Scotland and of course all the furniture and other fixtures were imported. The interior woodwork is very ornate--circular stairways, doors and wall paneling of hand-carved mahogany, ebony, and many kinds of local woods. The castle now belongs to the city of Dunedin and is maintained by a small charge made to tourists. On the way back to the city the bus stopped for tea at the Rhododendron Gardens which are one of the "must" sights in Dunedin. They are located near the shore of the harbor in a section that was once high-class residential area before the bay filled up with sand and the ferry boat ceased to ply these waters. The Rhododendron Gardens had been one of these fine old estates. It contained many large trees including sequoias and redwoods, all planted on a steep hillside and along a little canyon where numerous trails led through some of the most beautiful ferns and flowers I have ever seen.

Back to the Grand Hotel at 5:00 for the usual dinner which, this time, included Fish, Hot Joints, and American Ice Cream Sundaes--the latter a poor grade of ice cream covered with a yellow-green dope that I dubbed baby-beef bile.

After dinner I went across the street to visit with a Mr. Lowell, the District Governor of Rotary, South Island. He ran a Fruitary in the center of the city, a kind of store which keeps open until 9 or 10 o'clock in the summer evenings. He had recently returned from the International Convention of Rotary at Dallas and discussed

with great enthusiasm his travels in many parts of the U. S. and especially California where he had been interested in our methods of fruit production and sales. New Zealand farmers do not grade their produce to any degree or bother to put up a fine pack. He had been amazed at the high quality of our fruit and I could see why because New Zealanders have made no attempt to improve their plants. Tomatoes, for example, are small and warty and the quality is far inferior to ours. Watermelons, too, look as if the seed had not been selected in 40 years. Neither the outside, the inside, nor taste is attractive. While I was in the store a young couple came in and after much hesitation bought a slice of watermelon. The piece was about an inch and a half thick and as big around as a small pie. Mr. Lowell told me that they were having another couple in for dinner and that this small slice would be cut into four pieces for the dessert. The average American boy would have thought it a pretty stingy slice for one person. When I was ready to leave I tried to buy some fruit for the next day's lunch on the road, but Mr. Lowell would have none of it. He put up a hand-packed box of choice fruit and presented it to me--he said he had received many times as much in California and wanted to return a little of the consideration he had received there. The true Rotary spirit

January 18, 1959:

We left Dunedin about 8:15 a.m. and headed north for Christchurch. The road follows the coastline but except for a few short miles remains inland a mile or two from the beach.

The hills around Dunedin are volcanic, showing a black lava rock in the few road cuts that are deep enough to penetrate the decomposed red and yellow soils and reach the solid rock. Rolling hills rise 200 to 300 feet in a plateau above the sea and continue for about 25 miles along the coast until the road emerges to the ocean on sandstone cliffs about 50 feet high. It is here that one

finds the Moeraki Boulders mentioned in every tourist guidebook. These are sandstone spheres, ranging in size from a golf ball to as much as five feet in diameter. How were spheres formed? Nobody seems to know how they were formed. Me too! They are unusually round for such concretions and many show irregular ridge patterns on their surfaces that remind one of the curved stitched pattern of a basketball or baseball.

The road soon leaves the ocean front not returning until the town of Camaru is reached. This is quite a sizable city, perhaps 20,000 people, and is apparently a favorite beach resort. We saw many sailboats in a small cove and a good many bathers on the fine sandy beaches.

At Camaru the rolling hills give way to alluvial plains--this is the southern end of the plain mentioned earlier that extends south along the coast from Christchurch. In some of the freshly plowed fields the land looks to be half stones. Along here all the canyons proceeding from the mountains exhibit their old river terraces, usually only three or four. The uppermost is often ill-defined but the next is always clearly defined as to its top (tread) and is always the highest, as to face. The lowest terrace, next above the present river flood plains, has an average rise of about 10 feet and the next above 20 feet. Then a wide tread follows and ends against the big face (riser) that is usually higher than the lower two combined.

Another very interesting feature which I noticed in all of the river valleys along the 200 miles of this coast between Dunedin and Christchurch was that each one is cut strongest against the north bank of the canyon or valley. The highway parallels the long straight coastline called Canterbury Bight about 15 miles inland. At this distance inland the rivers have cut into the Pleistocene

See Fig 13

next-to-largest chunk of Canyon Diablo meteorite (from the Arizona Meteorite crater) in the world.

Our plane took off for Sydney at 5:00 p.m. We had a good view of the city and took several pictures of the huge reforestation project just to the southwest of the city. The trees seem to have been planted in mile-square sections with roads between. Some square were being harvested, the trees having been cut and laid in piles. As we passed over the higher foothills of the mountains I got some very good pictures of big river terraces at what must have been a similar elevation to those in the south of the island. In a cross-section of the island through Christchurch to the west coast, Banks Peninsula represents the lava section seen farther south. Then one passes over low ranges of shales and into schists and gneisses which form the highest part of the New Zealand Alps. The shales and schists dip toward the southeast and then toward the center they become vertical and finally the dip changes toward the northwest. At this point a deep and very prominent fault though extends as far as the eye can see to the northeast along the length of the island. This is followed by a string of monolithic granite mountains that rise almost as high as the main ridge, paralleling the trough on the northwest side. These are deeply eroded peaks with much land surrounding them and extending into the western coastal plain.

As we passed out over the western coastline, I got some good pictures of old Pleistocene flood terraces far below. There below was the main river valley and then a minor stream flowing parallel along the high terrace on the south side. Why it did not jump down off this higher parallel terrace and join the main river I could not see from my sky-high perch--17,000 feet. We could see the pyramid of Mt. Cook far to the south and the general snowfields of that area, although there had been only patches of snow on the mountains we had

just crossed over. As we cleared the coastline and passed out over the ocean the sun was going down and the vast sea of clouds which came under us was changed from pink to gold and then to steely blue, like a vast arctic ocean of ice.

We made up two hours of time in going west and landed in Sydney at 8:10 p.m. Sydney is a very beautiful city whether by night or by day and that night the lights of 2½ million people were all burning brightly.

4 connected

CHAPTER VI

EASTERN AUSTRALIA

Sydney is the second largest city in the British Commonwealth, a fact any American tourist will soon learn from contacts there. Its population is about 2½ million people and it has one of the finest harbors in the world the city being spread around it over a series of gently rolling hills. The big Sydney Harbor bridge, once the largest bridge of its kind in the world, joins the downtown section with the north-shore industrial and residential area and saves some 30 miles of travel that was once required in getting around all of the several arms of the bay.

In contrast to New Zealand, Sydney and the other big cities of Australia have many new business buildings and some new industrial plants and the general impression is one of a steady growth except for the depression years when nothing of any consequence was built here or anywhere else. The people, too, seem to have a little more aggressiveness than the New Zealanders.

The automobile is just coming into its own in Australia and the saturation point is being reached so far as parking and street capacity is concerned. It took us a solid hour to get out of the city when we took a bus to the Blue Mountains. The cause: 20 miles of traffic with stop lights. The streetcars have been replaced by busses but there are so many of these and so many taxis that traffic is getting to be a real problem. Sydney has a good many one-way streets now and while this helps it doesn't correct the crooked narrow streets and five-point intersections like Kings Cross.

We spent the first night in Sydney at the big Australian Hotel

downtown, but were told upon arrival that we could not stay more than the one night as they were booked solid. It was awfully hot and we lay on top of the sheets and sweltered all night.

January 19, 1959;

We found a room at another hotel near Kings Cross called Hampton Court and in the afternoon took a half-day tour around the south side of the city and the ocean beaches on that side. The harbor is enclosed by two long finger points which come close together to form what are called the North and South Heads. The harbor entrance channel between is only about a mile wide but very deep. The ends of these heads have been reserved for parks and military fortifications and of course the tourist is taken out on these vantage points to overlook the harbor. On the ocean side of these two peninsulas are the beaches where most of Sydney goes to swim in the summertime--January and February. The beaches are a series of coves with nice sand but interspersed with sandstone cliffs about 100 feet high where deep water and big waves dash against the cliffs.

Australia has been producing some of the best swimmers in the world and I suspect that it is a matter of the survival of the fittest. The sharks are very big and very numerous and hardly a week passes during the summer when someone is not eaten or badly chewed up. During the three days we were there a sailor was eaten by sharks when he tried to swim ashore from his ship, a lifeguard had his foot badly chewed up, and another lifeguard only saved himself from a 15-foot shark by swimming over a sandbar where the shark could not follow. There were thousands of people on the beaches but few dared go more than a little way into the breakers. Inside of the harbor we saw several swimming clubs where they had their swimming area fenced off with a heavy wire fencing material. The shark menace is no joke, and when you see the sharks they have mounted in the museums, all doubts you may have had

about the newspaper stories vanish. The great white shark grows to be 40 feet long and his mouth, when wide open, is easily three feet across, large enough for him to swallow a 250-pound man with ease. The great white sharks are not numerous ~~nor~~ very dangerous to man for they seldom come in close to shore. The big tiger sharks, however, are quite numerous and do come in close. They grow to a length of 15 to 18 feet, are quite aggressive, and can easily kill a man with one snap of their powerful jaws. This situation may have something to do with the general ^{lack} of enthusiasm for water skiing in Australia.

January 20, 1959:

In the Blue Mountains north of Sydney is the famous resort city of Katoomba with 15,000 residents the year around and many more during the holidays. It is easily reached by a double-track electric railway and the busy Australian executive can commute from Sydney in a little more than an hour.

Katoomba lies on the top of a plateau 3,300 feet above sea level in a eucalyptus forest which catches fire every few years and really causes a big smoke. The year before we were there this forest had burned and a great many houses in the outskirts of town were destroyed. Perhaps the biggest attraction in the area are the canyons which are cut back into this plateau. Vertical cliffs as much as 400 feet high are not uncommon, and in one of the canyons a good-sized stream produces a waterfall of quite respectable proportions. Across this canyon below the falls an aerial tramcar has been traveling for many years, carrying sightseers over the abyss. Far down the canyon, perhaps 10 miles away, you can see a 60-acre farm that is actually 1,300 feet below where you are standing on the brink. This scenery is without doubt the most awe-inspiring that I saw anywhere in Australia.

The top of the plateau at Katoomba is quite flat and the formation is a white, cross-bedded sandstone which lies in beds averaging about

four feet thick, the slope in one bed often dipping in the opposite direction of the one above or below. If these are sand dunes, as the textbooks generally aver, then what caused the top of each bed to be planed off so smoothly? I have never seen sand dunes in this condition. Perhaps the wind blew for 10 years in one direction and then suddenly reversed itself, for the next 10 years blowing in the opposite direction, and so on, back and forth, to make the alternating beds. This is a relatively small area of sandstone, perhaps a dozen square miles if we assume that it covered all the area now in canyons. In any event, it must have been a basin at one time so that the sand might collect there, but in addition we need an alternating climate wet to dry to go with the alternating winds, and subsidence at the proper time followed by a pause for proper plation of the surfaces. It is all quite simple if you are a proper kind of geologist and follow the rules: Don't ask foolish questions but believe what you are told. Those who are inclined to question will find themselves in a lonely little world of their own making.

One of the intriguing things about this area and, in fact, most of Australia is the nearly complete lack of Pleistocene gravels as found in other parts of the world. It is like Fiji: Only a foot or two of soil, at most, covers this plateau area. Even in the low country just to the north and west of Sydney where a small river flows toward the bay there is no gravel nor any sign that the soil is more than a few feet deep. It looks as if it had all been washed into the ocean.

January 21, 1959:

We left by train for Melbourne at 7:45 a.m. sharing our compartment with a young Australian couple and their two small boys. Our journey can best be described as something less than good. If you are young and have 20-20 vision, it is possible to read on one of these trains,

provided you are not given to seasickness. Eating a meal or drinking coffee is a real chore--there's many a stop between the cup and the lip. The reason for all this is that the railroads were built in 1880 or thereabout, and in those days they couldn't move dirt like we do now. Instead of building the road straight through rolling country by cuts and fills, they followed the contours around the hillsides. The track is therefore very winding and the train can hardly make more than 35 miles per hour. The distance from Sydney to Melbourne by air is 452 miles but by rail it is 590 miles--the 138 miles difference being mostly in turns, it seems.

The young couple riding with us were returning from a visit to his parents in Sydney, where he had been raised. His wife had grown up in Melbourne, and told us that it was a far superior city to Sydney. Then the argument began. We had already noticed in the Sydney newspapers that nothing is right in Melbourne. While we were there the newspapers were carrying scare headlines about the heat wave in Melbourne: "Seventeen Babies Die in Melbourne Hospitals". ("Seventeen Babies Dead in Melbourne 'Ospitals", the news hawks shouted). The lady from Melbourne assured us that the train service was much better in the state of Victoria. We made the change at Albury but couldn't see much difference except that the rails were about a foot wider apart. We arrived in Melbourne about 9:00 p.m.

When the railroads were built in Australia there was a big conference among the six states and the federal government as to who would operate the railroads, what gage should be used, and what other kind of equipment should be purchased. The federal government was, of course, for one standard gage, but because it was ~~then~~ not as powerful as the individual states it lost the argument and the states, through jealousy, all built different gage railroads. Now the federal government finds itself with six different gages of railroads and the necessity to transfer all

freight and passengers from one train to another at the state lines. A young Australian told me that his countrymen have been apologizing for this stupidity and threatening to do something about it for the last 50 years, but nothing is ever done. He averred that the government should junk the railroads, which are running at a \$35,000,000 loss each year, replace them with good highways which for the same money would carry both trucks and automobiles. Air freight is already of great importance in Australia where railroads and highways are so scarce.

For the whole distance of 590 miles between Sydney and Melbourne (except for the last 50 miles which I could not see because of darkness) I saw no sign of river terrace or gravel deposit of any kind. The railroad follows the ridge (it isn't a ridge at all but a near-plateau of gently rolling hills) which forms the divide between the short coastal rivers that flow into the Tasman Sea along the east coast and the many tributaries of the Murray River that empties into the Southern Ocean at Adelaide. The railroad cuts all show the same thing: Hard rock a few inches, or a foot or two at most, below the surface. The soil is very poor and very thin mostly a red clay soil three or four inches deep.

Going south from Sydney, the formation is massive sandstone for the first 85 miles. The strata lie in nearly level formation, the thick eucalyptus forest rooting down in scarcely more than two feet of soil and subsoil. At Moss Vale we entered a short stretch of volcanic rock and then went back into sandstone, this time tilted. As Goulburn we entered a granite region soon followed by volcanics. At each railroad station a sign gave the elevation and at Goulburn it was 2,090 feet. We were soon back into granite, this time low hills protruding from the plateau, each one covered with massive granite boulders. This was the highest point on the railroad and the

granite knobs appeared to rise about 500 feet higher. We came into metamorphic rocks steeply inclined and then into an almost vertical limestone. Following this the land fell away in very smooth rolling hills, not a sign of rock protruding through the surface. Every little cut, few of them more than five feet deep, showed a dark heavy-looking rock, probably a diorite, with seldom more than a foot of soil on the surface and almost no decomposition. At one place, Yass Junction, I did see in an unusually deep cut a cross-section nearly 20 feet in depth. Here there appeared to be about 15 feet of decomposed rock still pretty well consolidated but only a few inches of red soil on top. I marveled at the lack of decomposition and the extremely thin solid surface. Here in a land that appears to be so very ancient because it is smooth and completely lacking in surface boulders, one would expect to find a very deep soil and a deep decomposition of rock underneath that soil.

For the next 200 miles the train went uphill and down, gradually losing altitude. We had been at 1,126 feet at Yass and 200 miles farther south at Albury, down to 534 feet. Most of this country is so very smooth and so very gently rolling that no roadbed cuts of any depth were necessary; they had only needed to scrape the topsoil together in a low ridge about two feet high to form the railbed. We crossed several wide valleys without seeing any cut bank, but in two or three places trenches had been excavated in order to put new culverts under the track. Here I was able to see that about six inches of dark soil covered pink clay that might have been decomposed red granite. I saw no sign of streambed but the map indicated we were crossing branches of the Murray River. Probably when heavy rains occur the water drains off of these big flat plains without forming any definite ditch. Some of this flat land appeared to have faint mounds on its surface but I concluded that they were caused by the soil

building up around the scattered eucalyptus trees which cover this whole country. Where trees had been blown over and uprooted occasionally, the same pink subsoil could be seen. We did pass through some considerable stretches of farmland where wheat had been harvested, but nothing that one would call "good" land.

From Albury the railroad falls away a little into the Murray River Valley where we saw some good river silt soil right along the river bank and good orchard trees growing in the yards of the little country towns. Away from the river a few hundred yards, however, the same poor soil is in evidence. The eucalyptus trees are all scrub varieties that only grow about 15 feet tall and the grass shows the same lack of nutriment.

Far in the distance to the east we could see an occasional rounded mountain which appeared to be 600 or 700 feet higher than the plain. This was the Shathbogie Range, part of that vast mountain range shown on the maps of Australia as the Great Dividing Range. It parallels the east coast of Australia from Melbourne to well beyond Brisbane, a distance of more than 1,000 miles. I was to cross this range of mountains later as I flew from Mt. Isa to Brisbane. From the air it appeared to be a vast swell paralleling the eastern coast, with here and there along it an abrupt peak of hard rock thrusting through the plain. As we neared the coast this plateau broke off quite suddenly into more strongly eroded country, draining down to the ocean.

South of Albury in Victoria the railroad began to rise again and rolling hills provided some good-sized cut banks where I saw a yellow sandstone with the beds lying in almost vertical position. This continued for some distance and then the sandstone became interbedded with a hard blue shale. About this time it got too dark to see and all I could do was wonder, how come?

Nowhere else have I seen hard sandstone tilted so steeply, (here

nearly 90 degrees) that did not build steep bluffs or hog-backs rising above the softer materials on either side. Here in south-eastern Australia the smoothly polished hills and plains give not the slightest hint of those hard rocks lying so close beneath. It looks as though this area was once glaciated to a very high degree and then the surface was cleaned and scrubbed. Not so long ago either, because so little topsoil and decomposed rock is present. Never an erratic boulder of any size did I see on the surface, not even small stones the size of one's fist. Except for the small area of big granite boulders eroded out in place which I mentioned earlier, I saw nothing but smooth surfaces with the basement rocks close to the surface. If the continent of Australia is so very ancient as the orthodox geologists maintain, why is there no loose material on the surface? Why no sign of deep decomposition? If no oceanic flood waters or glacial ice overran this country in recent time, how is it that we now find it scrubbed so clean?

January 22, 1959:

After spending the morning arranging for tours of the area, we visited Melbourne University where I talked with Dr. Hills, professor of geology, and Dr. Baker, curator of the geology department's museum. I was also introduced to another Dr. Baker who was in the midst of writing a book on tektites--bits of natural glass which many scientists believe have an extra terrestrial origin. Tektites are found only in certain areas of the world and although they are similar in chemical composition, those of each locality share characteristics which distinguish them from other geographically located groups. Dr. Nininger, whom I would soon be joining in Perth, had as one of the principal objectives of his travels down under the search for and study of these interesting objects. Dr. Baker seemed quite confident that he knew most of the answers on the subject except for the actual

origin of tektites, and that he seemed to think unimportant.

January 23, 1959:

I went back out to the university and had a long talk with Dr. Baker, the curator. I took along the photograph I had brought from the States showing the unusual feature in Western Australia which I hopefully suspected of being a true impact crater. The photograph was an 8 x 8 aerial photo made by the Australian Air Force and had been taken from an altitude of 25,000 feet. The crater appeared to have walls on one side that might be as much as 400 or 500 feet high and contained a central island with a small crater in its center, this being the feature which had attracted Dr. Hossfeld's attention in 1957. Around the larger crater rim, which measured about five miles in diameter, there appeared to be both circular and radiating faults and, nearby, several small round basins which might be smaller craters, looking as if a cosmic herd of meteorites had struck here.

Dr. Baker and Dr. Hills located what they believed to be the feature in my photograph. It was called Grosse Bluff, they said, and showed it to me after much searching of their maps of North Territory and Western Australia. I did not think this circular mountain peak could be the same as the photograph which I showed them, but they were sure it was. Dr. Hills advised me to get in touch with the Zinc Corporation, a big company which was then exploring Grosse Bluff with the idea that it was a salt dome and might contain salt, oil, and sulphur, or possibly phosphorus.

In the afternoon I called the Zinc Corporation and the president, Mr. Hawby, invited me to come over for a conference. He introduced me to the head geologist, Mr. Osburne, and three associate geologists who dug out their maps and proceeded to tell me all about Grosse Bluff. When I showed them my photograph they agreed with me that

it was not the same place; Grosse Bluff, they assured me, was not a meteorite crater. One of the geologists soon located the quadrangle my photograph was in and it turned out to be far to the north and east of Gross Bluff.

The Zinc Corporation geologists were far more efficient than the university people. They had all their maps and aerial photos indexed and filed in order. At the university neither the maps nor the photographs were indexed or filed and they had gone through great stacks of things trying to find a map showing Grosse Bluff. Melbourne University, like the universities at Adelaide and Perth, complained of lack of funds to carry on research. Everything looks old and run-down and the salaries paid to professors would not attract anyone with real get-up and go. Consequently, there are few now in the field of geology or natural history doing work that amounts to anything. Most of the important research was done and the books written 40 to 50 years ago by men long since dead. They were men with drive and a strong determination to seek out the facts of nature and they went everywhere in the land when it was anything but easy to travel. Now the professors prefer to stay at their desks and analyze the material that is brought to them.

I was advised by Drs. Baker and Hills that a trip into central Australia in the middle of summer was practically suicide and that I should, by all means, wait until fall or winter for such a trip as I proposed. However, I decided to cross that bridge when I came to it.

January 24, 1959:

We had planned to go from Melbourne to Adelaide but the lady at the tourist bureau in the hotel advised us strongly against it. She said that the heat in Adelaide was much worse than in Melbourne and that the best possibility of getting out of the heat was to fly to

Tasmania, where we could spend a few days in a cool climate until the heat wave should dissipate. It was then 102 degrees in the shade at 3:00 p.m. and the humidity was about 80 per cent, so we bought tickets to Launceston, Tasmania, via Trans Australian Airlines.

As we cruised out over the deeply indented coastline of Victoria, I saw that the land was flat and covered with orchards and green fields, the freshly plowed land showing a dark color, indicating that here at least was good soil. As we passed out over Bass Strait, the pilot announced that our ground speed was 320 miles per hour and that we would arrive in Launceston in about 45 minutes. The hostess went through the usual demonstration of where to find and how to put on the life jackets. She stood at the front of the cabin and went through all the motions: I'm sure I'll never get tired of this demonstration.

We arrived at Launceston a little before noon and were to leave for Hobart by bus at 2:15 p.m. It was hot--at least 100 degrees--and we wondered if we were to escape the heat wave after all. We ate lunch in the local "Grand Hotel" across the street from the bus station, and because of the heat we craved water, but, as usual, none was to be found on the table. After several tries, we ^{did} ~~were~~ ^{well} were able to make the waitress understand what we wanted (down under no self-respecting native would be caught dead drinking water in a restaurant) and she got a pitcher of ice from the barmaid and filled it with water from somewhere. Since ice water is scarce and since there is no charge for ice, the American water-drinker is made to feel like a cheap-skate or a snob too proud to drink their good Australian beer. One might get about the same reaction by going into an American bar and asking for pink lemonade or a chocolate sundae. We ate our meal a little sheepishly and got back to the bus station.

Launceston is a city of about 50,000 people lying at the head of

a fiord-like estuary which penetrates the north shore of the island of Tasmania. The surrounding tableland is about 300 or 400 feet above sea level and good farming country, mostly in grain and pasture. We saw a few dairy cattle and many sheep.

We traveled south out of Launceston through farm country, long rolling hills which got greener and a little wetter as we continued south. The road runs from 30 to 40 miles inland most of the way and the beautiful farm country is much like Indiana or Ohio, except that the trees are all eucalyptus. Some original stands of forest remain, showing that some trees grew to a height of perhaps 125 to 150 feet with trunk diameters from four to six feet. Scattered old gnarled trees are seen in many of the wheat fields and pastures. Probably they were too big and too difficult to cut, so were left when the rest of the timber was cleared away. Many of these trees have died a natural death, but some have been girdled (the practice of making an encircling cut through the bark of a tree). I was told that an old tree can be killed by girdling but that a young tree will just sprout as it will if cut off at the ground.

We arrived in Hobart about 5:30 p.m. during a thunderstorm. We had no idea where our hotel might be, and we could not seem to find a taxi. I tried to call on a pay telephone and spent a small fortune before I found out how to work the thing. A call costs three pennies, the pennies being as large as our 50-cent piece. Three of these coins are placed in a sloping slot, then you lift the receiver and dial the number. When the party answers you punch a button and the coins fall down to complete the call. This sounds simple, but there are no instructions; you find out by trial and error, and I ran out of pennies before I found out the secret. We finally did manage to hail a taxi and got to our hotel, which turned out to be the nicest one in town, or so other tourists said.

Hobart is a city of 90,000 population situated on a magnificent harbor where big ships dock right down in the middle of the business district. The shoreline is rather steep and the buildings mount the slopes in all directions. Immediately to the east is Mt. Wellington, a forest-covered mountain that rises 2,500 feet above the city.

Our hotel, the Wrest Point, was quite new and modern and was about two miles south of the main part of the city. It stood on a point which juts out into the harbor about a quarter of a mile, and was surrounded by extensive lawns and gardens and an enclosed and heated swimming pool. On either side of the point yacht clubs have their anchorages so there is always something to see in the way of boating. The harbor at Hobart is called Storm Bay but it is not well named, according to one guide. He said that Storm Bay is a yachtsman's paradise with more than 200 miles of waterways enclosed from the open sea. We drove around part of this shoreline and found it to be a seemingly endless variety of coves and inlets where small craft can anchor.

We had dinner in the hotel dining room overlooking the harbor, that end of the hotel being built to look like the super-structure and bridge of an ocean liner, with a series of decks one above the other.

January 25, 1959:

We awoke to find that the thunderstorm had moved away in the night leaving a low-hanging misty rain falling steadily--making the day anything but good for sightseeing. We took a bus tour around the Hobart area, following a circular route around Mt. Wellington and up to the top of the peak, a total distance of about 125 miles. It took most of the day because the bus drove slowly and stopped for morning and afternoon tea as well as lunch. The first leg of the journey took us along the south shore of Storm Bay for about 30 miles

where we rounded a point and turned back up an inlet for about 10 miles to a small town called Cygnet. Here a small river valley meets the sea between heavily forested mountains. The river itself is quite large because the rainfall along this coast is over 50 inches and more at higher elevations. Good-sized ships can move up the river a little way to load lumber. We saw many small farms, orchards, and dairy farms, and blackberries were growing in great profusion along the road. The road was narrow and crooked, but oiled (sealed) all the way. One little town along the way is famous for its flower gardens. The houses are set well back from the street, about 100 feet, and each householder seems to try to outdo his neighbor in the beauty and diversity of his garden. The continual rainfall and the hothouse type of climate makes the end product worth the effort. We stopped at a little country hotel for lunch where about 20 of us were served country-style at two big tables. The food was really good.

From this point the road starts to climb Mt. Wellington. It had been raining and misting all morning, sometimes with the fog and mist right down to the ground. All the steep hillsides which are not farmed are covered with big eucalyptus trees which look like what we call bluegums in California. The forest grew thicker and the timber taller as we climbed the mountain on a winding grade. Half-way up there is a hotel and tashouse where our driver stopped to inquire about the road ^{farther} up. The road was all right, they said, but there was nothing to see but fog. The view from the top of Mt. Wellington across the mountains and valleys of Tasmania, the islands and indentations of Storm Bay, and the city of Hobart is said to be one of the outstanding sights in the southern hemisphere. We went on to the top hoping it would clear, but all we saw was fog and each other.

The last 1,000 feet toward the top of the mountain is very steep,

the road being cut out of the volcanic rock. Eucalyptus trees continue to grow almost to the top where they are dwarfed and bent over by the wind and snows of the antarctic winter. Hobart is 44 degrees south and this mountain peak gets plenty of snow in the winter. I was not aware that any variety of eucalyptus could stand this much cold. The last 150 feet is barren of trees but is covered with various kinds of dwarfed shrubs, grasses, and flowers. Among them is a kind of heather and what appears to be a recumbent conifer, creeping along the ground among the rocks, lichens, and mosses. The conifer looks like a yew.

On the small flat area at the top of the peak, frost had fractured the basaltic rocks and squeezed some of the blocks upward in small monument-like projections. A little below the top were a number of rock glaciers that extended down the mountainside for several hundred yards. These were beds of lava boulders that would average three or four feet in diameter, all very angular and in a stream perhaps 75 yards wide. There must be some downgrade movement of this rock because the dwarf eucalyptus trees grow up to the very edge of the rock stream, but not in it. It may be that this stream of boulders results from an intrusion of columnar basalt that lies beneath. As the frost and ice expand and contract with the seasons, the ends are broken off these basaltic columns below and they are thrust to the surface in a hodge-podge pile of loose boulders which slowly move down the mountainside under the forces of frost and gravity. I would have liked very much to have had a full day to hike around the top of this mountain to examine its geology more thoroughly, but time did not allow.

One of the other passengers on the tour, Mr. Williams, a math teacher, told me that they were having the same troubles in education in Australia that we are having in America. In fact they have been apeing our methods to the detriment of their schools, he said, teaching

a whole array of social-study courses while neglecting the fundamental subjects, and requiring men like himself with 20 years of experience to take courses in education when what he needed was a new and better way to teach math.

Our bus driver, a man of about 55 years, in telling of his experiences at Darwin during the war, made the statement that "the Yanks saved our skins". Apparently the Yanks saved the Australians by the naval engagements farther north in the Pacific Island actions, not at Darwin. Another passenger, a lady from Sydney couldn't believe it. He went on to recount that there had been over 40 bombing raids within 60 days at Darwin and that more than 2,000 people were killed by the Japanese air attacks. This I later confirmed while at Darwin. It seems that the Australian government did not allow the news to leak out to the Australian people at the time for fear of panic, and after the war was over very little was said about it. It was news to me, as well as to the lady from Sydney.

We returned to Hobart by a different road which took us through some of the big trees. We saw some trees which appeared to be as much as seven feet in diameter at about that distance above the ground. Much of this forest on the eastern slope of Mt. Wellington has been burned within recent time--I should judge about 30 or 40 years ago. These eucalyptus grow to the greatest size on the steep slopes of the mountain peaks where elevation and air currents produce the maximum rainfall. The bus driver told us that on the wet side of the island of Tasmania (southwest side) there is a big valley that leads to the top of a 5,000-foot peak in a sort of funnel shape and that the biggest eucalyptus trees found anywhere down under grow there. He said there are trees in this area at an elevation of about 3,000 feet which are as much as 17 feet in diameter and more than 300 feet tall. The precipitation there is over 100 inches, he said, and the area is

quite inaccessible to any but the seasoned^{and} determined traveler. It is in this region too, he said, that the reclining jungle is found--a growth of a peculiar shrub which is so thick and lies so close to the ground that the only means of travel is over the top of it, and that not easy!

We got back to Wrest Point Hotel about 5:45 p.m. and after a tour of the grounds to take more pictures, had dinner and went to bed.

January 26, 1959:

The Hobart airport is about 15 miles from the city and to reach it we took a bus north along a park by the side of the bay. After a mile or two the bay narrows to about a half-mile and here a concrete pontoon bridge has been built to shorten the otherwise long trip around this arm of the bay. Every city worthy of the name must have something that is the largest in the world and Hobart has the largest pontoon bridge. It is a loose-jointed affair made of concrete barges connected with cables, and it swings with the tide. When we crossed it, the tide was coming in and the center of the bridge must have been about 300 feet upstream from a line straight across, making quite a beautiful curve. Trash screens were located both upstream and downstream from the bridge, I suppose to keep sticks, logs, and other floating trash from getting into the joints of the bridge.

The road passes over a low range of hills and down to a plain beyond which ends at another arm of Storm Bay. This plain is quite extensive and is covered with a check-boardⁱⁿ pattern of reforestation, mostly pine trees. In this setting we found the airport, new and modern in every way. The plane ride back to Melbourne was uneventful, cloudy most of the way.

Back at the Menzies Hotel, we rested up a bit then took a taxi out to the big city park where Mrs. Kelly had heard the botanical

gardens were beyond compare. I followed her through endless trails and hoards of people; ^{read} ~~read~~ hundreds of latin names tacked on every variety of eucalyptus tree that God ever made; tramped through jungles and around lily ponds--the latter filled with ducks and completely surrounded by children. At last we reached the cigarette-paper-bark-tree I had heard about and found that it looked like a cork oak with a bad case of sunburn and the skin just peeling off. I marveled at a nearby giant cypress, the largest I had ever seen and, after catching my breath, I was able to read out loud: "Monterey Cypress (genus *Chamaecyparis*)". I rested a few minutes on a bench under a sequoia tree while I copied down this latin name, while Mrs. Kelly dashed from flowering bed to flowering tree, then staggered on, trailing through the trailing arbutus and finally reaching a tea room where "sweets" were on sale. Got a couple of candy bars inside, the only thing that enabled me to make the last agonizing mile to the taxi stand. No geology in sight! Ah me!

January 27, 1959:

We took the bus trip to North Victoria, an all-day, 200-mile ride through what is considered the most beautiful part of southern Australia: Mountains and lakes, open fields and rivers. Also included in the trip was a five-mile boat ride on a newly formed lake which is part of the water system of the city of Melbourne. This is a man-made lake behind a "wall" (they don't dam rivers in Australia as they do in the U.S.) 250 feet high and 9,500 feet long. There was already a small lake here behind a lower wall but now the new and higher wall provides a much greater supply of water. This is the biggest and highest wall in the southern hemisphere and it belongs to the city of Melbourne, a fact that must make those Sydneyites squirm. The captain of the boat told us all about it over the loud-speaker: How the contract was given to the Utah Construction Company

and how they battled for four years with labor strikes, and lack of pay from the Australian government, and how they had to leave most of their profit in Australia so they used it to build Mormon churches. Knowing the record of the Utah Construction Company, one of the largest in the world, I would judge that they could have built a dam this size in the United States in a little more than a year. In any event their work was blessed, for no sooner was the wall finished than it began to rain and rain and rain. One of those wet seasons that comes once in 50 years filled the lake and had water running over the spillway within a few months. It had been expected that it would take 15 years to fill the basin on the basis of the average rainfall.

On the way over the mountains to the lake we reached an elevation of over 1,200 feet and saw some of the big trees which grow on the mountain slopes in this area. According to the bus driver the trees here are called swamp gums and some of them grow to a diameter of over eight feet and nearly 300 feet tall. A very bad fire burned through this forest in 1939 killing thousands of acres of the big trees leaving only a few in scattered groves. The bare trunks and main branches of these burned giants still remain standing, reaching far above the tops of the young forest. Much of this young forest was replanted in rows eight feet apart and now the trees stand fully 100 feet tall and only about 12 inches in diameter.

January 28, 1959:

We left for Adelaide by bus at 7:30 a.m. It is a long trip by bus, over 13 hours elapsed time and nearly 500 miles, but it is a much better way to go than by train or air if one wants to see the country.

The suburbs of Melbourne are built on low rolling hills around the harbor (Port Phillip Bay, as it is called) and we had soon passed through them and were out on a low level plain. For miles and miles

we traveled across these lava plains covered with a yellow bunch grass and dark lava rocks that looked for all the world like thousands of black sheep scattered over the plains. Near Geelong, a good-sized city on the other end of Port Phillip Bay and about 50 miles from Melbourne, we made a right-angle turn to the northwest and headed toward Ballarat. From this turning point inland we began to rise slowly. The land was getting a little better and the stones a little smaller so that the farmers could move them from the fields into stone walls. For miles and miles the road was lined on either side with stone walls five feet high and half as thick. When one contemplates the labor that these early pioneers went through in clearing this land of lava boulders, the back begins to ache and the hands and head to shake. How did they do it? Probably with stone boats pulled by teams of horses and plenty of back-breaking labor.

The soil continues to improve as the tableland rises and some wheat is grown, although sheep seem to be the main source of income. On either side of Ballarat there are quite a number of very ancient volcanoes rising from 300 to 600 feet above the plains. They look like cinder cones with all the loose cinders removed down to the solid rock. The plains are ancient lava flows as shown by the occasional lava canyon that proceeds toward the sea. Seldom more than 30 feet deep and a few hundred feet wide, these lava canyons have perpendicular walls that show a cross-section through the beds of lava and the volcanic ash between. Little or no sign of stream flow is visible in these canyons and one wonders how these lava beds were made and how lava could flow so very far with so little gradient toward the sea.

Ballarat is an old gold-mining town which has seen better days but which still produces some gold. The most interesting thing we saw there was the World War I memorial avenue of trees. This mining town seems to have produced a large force of war heroes who were

marched up to the German machine guns. A little way out of town where the main street becomes the highway, a row of trees has been planted on either side of the road, one for each soldier who died for his city and native land. Most of the trees are sycamores, well cared for and spaced about 30 feet apart. They have now grown together so that the branches join, making one long band of green-- a beautiful memorial indeed. The only sycamores I remember seeing in Australia.

Journeying on through better farming country, we came to Ararat, another mining town about 60 miles from Ballarat. The land had been rolling, uphill and down, but always rising a little so that here the elevation was more than 2,000 feet. Some of the hills are another 500 or 600 hundred feet higher and one near the town of Ararat is actually 3,247 feet in elevation--a real Mt. Ararat, only 13,653 feet short of its namesake in Armenia.

The gold mines of Ararat according to local claim have the distinction of having produced the largest gold nugget ever found--about 24 inches long by 18 inches wide and above five inches thick. It taught me a lesson: My boyhood dream of finding gold nuggets as big as my fist were far below the maximum size of which dreams should be made.

Beyond Ararat we passed through Stawell, Horsham, and Dimboola, three good-sized towns in a reasonably good farming country. Then we came into a very unusual granite country of swell and swale topography. I have called this swell and swale topography for want of a local name. In searching through the geologic literature of Australia I was unable to find any reference to this type of topography. Probably because it is so commonplace that those people raised there see nothing unusual about it. At one place along the road a group of very large weathered granite boulders sat upon the plain among a grove of eucalyptus trees. These boulders are such an unusual sight in this part of

Australia that they have been set aside as a little park and camp ground. The swell and swale continues for about 30 or 40 miles-- hills two to three miles across from swale to swale and perhaps 100 feet high. Still more curious, this granite swell and swale country turns into a ridge and trough topography that continues for many miles. Ridge and trough topography can hardly be described better. Its a series of long ridges and troughs which extended as far as the eye could see in either direction. The relief, height of ridge above troughs is about the same as in the swell and swale. I began to count the ridges and the telephone poles along the road to estimate how many miles it was from trough to trough. It turned out that there were 12 ridges and they averaged about 20,000 feet from ridge to ridge or trough to trough, estimating the distance between poles as 250 feet. The height of the ridges above the troughs I judged to be about 250 feet but this is only a guess because it is very hard to judge accurately because of the long distances between ridges and the gentleness of the slope. One may try to estimate the number of times a 30-foot telephone pole on the distant horizon may go into the slope of the hill from the bottom of the trough to the top, but it is only a guess. Good estimates of the height of barns or windmills along the road may be made but again--how high are they compared to the hill or ridge that may slope for two miles up to the top?

In any event, these ridges extended as far as the eye could see in either direction. There was no sign of even the smallest rock anywhere on the surface, which was smooth and perfect in contour. The only clues I had as to the rock formation beneath was the fact that we had passed through granite country before and had continued into a red sandy clay soil that looked like decomposed granite. Ordinarily one would expect long parallel ridges to be folded sedimentary rocks, but here there was no sign of such rock. The ridges merely

got progressively lower and finally merged into a plain covered with fossil sanddunes.

Here the road turns a little more to the northwest and parallels the long-curving beach seen on the map called The Goorong, but the road is nearly 50 miles inland. This area is called the Sixty-Mile Desert but it is not really a desert; only semi-desert covered with dunes and much of the land having been cleared and farmed to grain. The dunes are covered with scrub acacia and other varieties of brush strange to me, but withall, a dreary country in which to live. The flats between the dunes show a thin grey soil and in places where holes had been dug a white limy clay soil, sometimes called galicha, was seen. Just before reaching Adelaide the road climbs from these near sea level plains over a low line of sedimentary hills that may be 1,000 feet in elevation. We did not see these hills from the bus because we crossed over them at night, but later, flying in and out of Adelaide, I had a good view of them.

January 29, 1959:

We were up at 5:30 a.m. to get Mrs. Kelly off on the early plane to Sydney. It was a hard battle for me to let the "little woman" go home and leave me in the big, wide, strange world, but it had to be for that was the way we had planned it. She found a seat by the window where she could wave good-bye as the plane took off. Now it was up to me to take care of all the details myself, a job I had wished off on her up until the parting moment.

I was not to leave for Perth until 2:00 o'clock in the afternoon, so I went back to the university in hopes of finding Dr. Hossfeld with whom I had corresponded about a year and a half before in regard to the suspected meteorite crater near Alice Springs.

At the university I met Dr. Alderman, head of the geology department, with whom I had tea while discussing geology in general and

meteoritics in particular. In 1932 Dr. Alderman had written the first description of the Henbury meteorite craters of central Australia, craters the Miningers and I planned to visit during our travels together. I told him about the suspected crater I was hoping to visit, but he was not at all sure about its location. Dr. Hossfeld, he said, had visited the suspect twice.

When Dr. Hossfeld arrived about 11:00 a.m., he told me of his trips to the place and located it quite accurately on the map for me. It is called Lake Eaton and is located about 220 miles northwest of Alice Springs. He said he nearly lost his life the second time he went there. They had run out of water and nearly out of fuel, but fortunately it was in the wintertime and not too hot. He advised strongly against going there in summer.

Dr. Hossfeld gave me a geological map of the Northern Territory of Australia which he had completed in 1951. He said his colleagues made fun of his efforts, but it was far more than any of them had done. It was done in 17 different colors and showed the various formations in the five different epochs of the earth's history, beginning with the Archeozoic and ending with the Cenozoic. He pointed out the many question marks on the map, indicating uncertainty as to the actual size and kind of formations. Later, as I traveled across this country by air, I understood better what he meant. Probably 95 per cent of the whole area is flat and devoid of any rock outcropping to indicate what the formation below might be. We discussed cosmic collision at some length and he said that he had become convinced it had been a much more important force in building the earth than had heretofore been believed.

I boarded the plane for Perth at two o'clock. The weather was hot but clear as we climbed out over the Gulf of St. Vincent, crossing Yorke Peninsula, Spencer Gulf, then Eyre Peninsula and

finally out over the Great Australian Bight, the plane being out of sight of land for more than 600 miles before intersecting the coast again at Point Culver. Much to my delight the first thing I saw over Yorke and Eyre peninsulas were dozens of circular dry lake beds that looked for all the world like the Carolina Bays, that peculiar series of a oriented shallow depressions along the south Atlantic coast of the United States about which Melton and Schriever wrote in 1944 and which first drew my attention to the possibility of cosmic collision.

The Australian basins appeared to range in size from a few hundred feet to several miles across and were all shallow--about the same depth as the Carolina Bays and the Oriented Lakes of northern Alaska. As the plane passed in over the coast again ^{near} Point Culver I began to see hundreds more, stretching away as far as the eye could see. I learned later that the whole of southwestern Australia is covered with these dry lake beds, practically all of them in granite country as shown on the geological map of Western Australia. This fact eliminates the possibility of their being "sinks" as found in some limestone formations.

The Carolina Bays, at the time they were first noticed by scientists in 1932, were thought to be meteorite craters, but it has since become apparent that they have none of the characteristics which mark craters left by meteoritic impact. In TARGET: EARTH we discussed the probability of the Carolina Bays being formed by bergs of sea ice left stranded by the receding waters of oceanic flood. The Australian lakes have strongly marked shorelines on the northeast and little or no shorelines on the opposite side, a condition which could well be the result of ice melting more rapidly on one side (the sunny side) than on the other. Could the same collision and oceanic flood that produced the Carolina Bays, the Alaskan lakes, and some which are supposed

to be in Siberia, also have produced these in Australia? They are all of late Pleistocene time and the south coast of Australia was in a fine position to catch ice cakes from the near-by south polar ocean.



3

CHAPTER VII

INTO THE BUSH

Our plane arrived in Perth about 6:00 p.m. and after the usual bus ride into town I caught a taxi out to the Charles Hotel where I was to meet the Miningers. I arrived there a little before 8 o'clock and found them in the dining room waiting for me. We talked that night until nearly midnight and decided, among other things, that we should rent a car and take a week's trip around the perimeter of Perth. Later we would take a larger circle, including a 1,500-mile-drive across the Nullarbor--a stretch of road across the desert which we soon found was regarded by Australians as almost impassable except by train or plane. We agreed to be cautious, but went ahead with our plans. How else, if not by car, was Dr. Mininger going to make his intended search for tektites and meteorites?

January 31, 1959:

We rented a new Holden for our trip into the bush. The man at the rental agency got us started out of town on the right road and I concentrated on staying on the left side of the street. The difficulty comes when you get to a strange intersection and try to think which way to go, read the signs, and try at the same time to remember the left-handed rules. As soon as one concentrates on something else the car seems to get back on the wrong side of the street. Dr. Mininger said he knew he couldn't possibly drive in the city, and he later refused to drive even on the country roads.

The city of Perth is inland about 10 miles from its seaport which is called Fremantle. It lies on a rolling plain about 100 feet above

sea level, but this is only a narrow strip along the coast about 20 miles wide. The area has a climate very much like southern California except for greater rainfall--about 20 to 25 inches annually--and more humidity in the summertime. It is good farm land, consisting mostly of small farms and orchards.

Inland about 20 miles the coastal plain makes a sudden rise to an elevation of about 1,000 feet and continues this height all over Western Australia. This hill country is well wooded close to Perth and has many fine apple and pear orchards. As soon as the top of the plateau is gained the orchards give way to grain fields, mostly wheat.

This country along the edge of the plateau gets a considerable rainfall so that the forest has a thick undergrowth, mostly of tree ferns and blackboys. A blackboy, also called grasstree, is a yucca-like plant that grows from a few feet to as much as 10 or 12 feet high. Its grass-like fronds die and are shed like a palm frond. The trunk is smooth and six to eight inches in diameter and the fronds are long, narrow stems no more than a quarter of an inch thick at the base and about two feet long. The green fronds arch out in all directions in a thick bushy top and the dry ones hang down like a skirt. They are called blackboys because when fires burn through the forest they clean off all the dry skirts and burn the trunks black. Then in the course of a few years another dry skirt grows again and at a distance the palms look like a group of black-legged natives standing in the forest.

All over the plateau area we saw laterite (ironstone, the natives call it), much of it consolidated into a conglomerate-like layer that covers the decomposed granite below. It is composed of little spheres about the size of ordinary marbles, the smallest about one-quarter inch in diameter and the largest about three-quarters of an inch. It looks like red peanut-brittle when a chunk is broken. It makes

wonderful road beds, packing down into a hard surface which, when oiled is unsurpassed as a road material.

There is no orthodox geological explanation for laterite beyond the following sentences taken from the Geological Survey Bulletin No. 95, Page 322:

Its formation is essentially due to the decomposition of rocks by which iron, silica, and aluminum are dissolved in circulating underground water. Portions of that water is drawn to the surface by capillarity, and laterite is precipitated on the underlying decomposed rocks, which it greatly protects from erosion.

This is a rather brief explanation for a blanket of material that covers practically the whole of Western Australia, great areas of the eastern states and in the north around Darwin. It is found as an ironstone, limestone, and bauxite formation. In the north around Darwin the aluminous-oxide variety is found as nearly round pills about the size of BB shot. This shot-like material is bright red and the samples I saw so loosely held together that they could be easily broken apart with the hands. The fine cementing material between the spheres seems to have been washed away or never was present, which is a very unusual circumstance.

In the limestone areas of southwestern Australia, the laterite spheres average larger in size even than the ironstone variety. Many are as large as golf balls although the average size would probably be about half an inch in diameter. Many of these spheres are found to contain angular bits of stone that look like a dark green lava with layer upon layer of a limy material having been formed around it until the final product is nearly round. The ironstone and aluminous spheres also have small specks or particles around which the sphere has developed, in much the same way as a concretion is supposed to grow, layer by layer.

See plate
no ←

It should be understood that laterite is like a blanket of hailstones covering the whole of Western Australia three to five feet thick. On hilltops and in valleys it averages about the same thickness, although

at one place near Corrigen it lies up against a big granite dome like a snowdrift. Here they had worked out a deep gravel pit, getting laterite for the highway. The cut bank was at least 20 feet high and it looked as if there might be another 10 feet of the same material, so uniform in size that it looked as though it had been screened. The big granite dome behind the town of Corrigen is about 75 feet high and must cover at least 40 acres. The east side rises abruptly out of the plain, but the west side slopes under the laterite for perhaps a quarter of a mile, the drift of laterite actually being higher than the top of the granite dome.

I suspect that laterite is a product of collision-flood--a sort of "fallout" product that had its origin in the vast clouds of incandescent dust produced by collision. Not the collision of 11,000 years ago but one of the several near Australia such as Fiji, Sunda Arc, or Celebes and Moluccas arcs which are all close to Australia and we think, overlapping collision points. Angular particles of rock or grains or sand thrown to great altitude fell back through this hot dust, collecting layer upon layer of this semi-molten material like ice accumulating on hail stones.

Another possibility is that the angular bits of stone fell into deep ocean water ^{roiled} rolled up by the collision and that the layers of iron oxide, lime, or aluminous material collected on their surfaces as the bits of stone tumbled through the turbulent water toward the bottom. The time required for these bits of rock to fall through a turbulent atmosphere or sink to the bottom of a ^{roiled-up} rolled-up ocean would determine the size of the spheres just as the size of hailstones is regulated by the time they may be falling through a freezing zone.

A large collision would conceivably provide both of these (falling through atmosphere of hot dust or falling through deep ocean water) conditions somewhere within its periphery. It is possible, too, that

the moving waters of the oceanic flood carried the laterite stones for considerable distances, depositing them as a blanket of quite uniform thickness. It is inconceivable that any of the ordinary forms of erosion or weathering could have produced this blanket of material. How could this vast bed of tiny stones been turned, over and over, each by itself so that the layers of material could have been deposited to form a rounded stone? Certainly not on the bottom of the ocean, and most certainly not by river action, for the laterite covers the entire country like a blanket of snow.

The arcuate structures which bound Australia on the north and east are probably ancient collision scars. The Sunda Arc is one of the largest in the world and it is followed on the east by the Celebes and Moluccas arcs and the Solomon-Fiji-Tonga group, all of which have a continuous record of seismic activity and volcanic action, indicating the gradually dying (cooling and contracting earthquake) activities at these points of cosmic collision.

The physical evidence indicates that the Australian continent is very old and was probably once deep sea bottom that has been raised step by step (in my opinion collision by collision) to its present position. Never having received a direct cosmic hit, but half surrounded by collision points, it has been raised to its present elevation as a stable land mass. Like other large stable land masses and most of the deep ocean floor, it is relatively free from seismic disturbance, having had only five small earthquakes since seismic instruments have been in use. Its few volcanoes and other signs of volcanic action are very old and of minor significance. Most of its sedimentary rocks, too, are very old, having been tilted often 90 degrees and folded until in many places they look like heavy dough mixed into all sorts of queer configurations.

Another indication that the down under continent was once deep

sea floor is the gigantic swell and swale topography mentioned earlier. The greater part of Western Australia, roughly 275,000 square miles, is underlain with granitic rocks, most of it of swell and swale topography and all of it averaging about 1,000 feet above sea level. Intruding through this granite basement are isolated islands and ridges of greenstone, (a heavier basaltic rock) that in some places rises to as much as 1,200 to 1,400 feet above sea level. It is at these greenstone outcroppings that gold is found.

The swell and swale topography varies some from place to place but in general the swells average about five miles from top to top or about the same distance from the bottom of one swale to the bottom of the next with the difference in elevation being 150 to 200 feet. As one drives across this country the views from the tops of the swells give the impression of one vast plain stretching in all directions as far as the eye can reach, here and there relieved by a dome of hard, exposed granite which may rise from 50 to 100 feet higher than the average swell. It is all a coarse-grained pink granite and many of the domes have "potholes" of considerable size on their surfaces. Many of these granite domes are no more than a few acres in extent and 6 to 10 feet high, but some of the larger ones appear to cover an area of as much as 100 acres and reach heights of 75 to 100 feet. Because they provide a perfect roof to catch rainwater, most of the farms, sheep stations, and towns are located near such domes. Everywhere else the blanket of laterite covers the landscape and drinks up the rain as fast as it falls. Never a stream is to be found and even the bottoms of the swales seldom contain a dry-lake bed, and this is in an area where there is from 15 to 20 inches of rainfall, depending on the distance from the coast. In no other land, so far as I know, does this much rain disappear without trace of streambed or lake.

Since the advent of echo sounding, most of the deep sea floor has been found to be of this swell and swale topography, often with a greater relief^f (larger hills and deeper valleys) but the same general form. Submarine ridges and seamounts are, of course, quite common, but most of the deep sea area is of this swell and swale relief. When depth soundings were made by cable at intervals of 40 to 60 miles, the impression was gained that the deep sea floor was a nearly level plain. Now continuous echo sounding gets a reading every few feet along the route of the ship, and the record shows this swell and swale topography.

Another bit of evidence that Western Australia was once deep sea floor is the fact that practically every square foot of this area is underlain with strong salt water. A sheep station owner who had many wells scattered over his 303,000-acre station near the town of Mount Magnet told us that the blanket of laterite was underlain with about 20 feet of clay or decomposed granite above the solid rock and that they had found it useless to dig a well over 10 or 12 feet deep because only the surface water was potable. He said that the water immediately above the solid rock was as salty as the ocean and that this was true everywhere they had tried to go deeper than about 12 feet. I noticed farther west in the grain belt that most of the windmills were located on the tops of the swells and in talking with state geologists later I learned that this was not to take advantage of more wind on the hilltops but because the ground water was less salty.

The swell and swale topography is not mentioned in any of the geological literature I was able to obtain in Australia, this area being described as a tableland or plateau without considering the depressions or lack of streams as anything unusual. Nor is the widespread salty ground water considered as an anomalous condition.

Charles F. Laseron, in his book on the geology of Australia (The Face of Australia, Page 45) makes the statement that Western Australia

has been above sea level since Archeozoic time, giving an estimate of 1,500 million years as the time. This vast granite plateau, he says, represents the roots of mountains long since worn to a level and that for the last 700 million years the land has remained virtually unchanged. If so, why did the mountains wear down to humps and hollows and why was the salt not leached away to the sea?

The first day out from Perth we reached a town called York about 11:00 a.m. and all hands began a search for someone who might know about meteorites or tektites. We asked many people on the street and in the bank and in the pubs. We got a few good leads but they all fizzled out.

We drove on to Corrigen where we got lodging at a very old hotel. Dr. Nininger went down to the bar to talk to the local citizens and came back with the news that he had found a man, Mr. Turnbull, who had a very large australite (As Australian tektites are called) that we might see on the morrow.

Corrigen is a typical "back bush" country town: Old 1890 buildings with corrugated tin roofs painted red, umbrella trees along the streets, and windmills in the back yard. I counted 21 windmills from the upstairs veranda of the hotel and could only see half the town from that side of the building.

Almost everyone, we found, knew about the black glass australites and could tell of someone who had a few, but most of them had been lost or thrown away since the museums had stopped buying them years before.

February 1, 1939:

We began a Sunday-morning tour of the outlying farms where we had heard that australites might be found. Most of the people were not at home but we found one man playing cricket with some of his 12 children. The oldest boy went into the house to get his collection and that

brought out the mother who had just had the last baby two weeks before. She was a very thin bird-like little woman who was apparently the most enthusiastic tektite hunter of them all. She had found two herself and had been urging the two oldest boys to watch for them in their farm work. Dr. Nininger happily bought the seven specimens they had managed to collect.

We drove the Holden about 100 miles during the day looking for people in the surrounding farms and small towns but nobody else was at home. Returned to Corrigan about four o'clock and found everyone playing bowls, tennis, or drinking beer. It was plenty hot, about 90 degrees in the shade, and it appeared to me that the beer drinkers were having the best of it.

Bowling on the green is a favorite sport among the Australian country folk. They form a club and the better people put in some money to build a small clubhouse and a green. Everyone dresses in white--hats, shoes, the men in long trousers, the ladies in white dresses. Mr. Turnbull, one of the bowlers, turned up with the very large australite which he wouldn't sell. It was not quite symmetrical in shape but was perhaps the largest one we saw anywhere except in museums.

Dr. Nininger has offered the theory that these bits of black glass are the result of large meteorites blasting a shower of molten rock off the moon. Cooling immediately, it became a true glass. If the earth chances to intercept such a shower, the material may be scattered over thousands of square miles. Other than in Australia tektites have been found in the Philippines (risalites), in Indo-China (indo-chinites), in Texas (bediasites), in Bohemia (moldavites), on the island of Billiton (billitonites) and recently some have been discovered in Georgia. In Australia tektites are scattered quite evenly over the southern half of the continent, roughly south of a line drawn

from northwestern Australia in the Kimberly country, southeasterly through Alice Springs and reaching the eastern coast between Brisbane and Sydney. I say quite evenly, but actually no one knows how evenly. We were told that in certain localities they were quite plentiful. Natives said that they knew of places far out in the brush where tektites could be found in great abundance, but the white collectors who had found them and the museum people all told us that it was a rare experience to find an australite, even in the areas where they were supposed to be abundant. The family of 12 mentioned above had found only seven tektites in the several years they had been keeping a watchful eye and it seemed to be the opinion of most collectors that not more than two or three could be found on an acre of ground if the surface soil were screened.

Nevertheless, as we traveled along the country roads we kept a constant watch and stopped many times each day to look closer at some small black object. In most cases these objects turned out to be kangaroo manure which is exactly the size and shape of a medium-sized australite. After many disappointments we began calling this material "Kangarooite".

It is an interesting fact that practically all the tektites found have been in the top few inches of the soil or actually on the surface of the ground. This would seem to indicate that they are all of very recent origin whether found in one part of the world or another. They are a rather weather-resistant material and should have survived in the unconsolidated Pleistocene sediments and the much older sedimentary rocks if the earth has always been exposed to these showers; especially in lakes and river muds where plant acids are not strong. Why, then, have they not been discovered in the older sediments?

Most of the Australian scientists seem to favor the proposal that tektites are the surface material melted off of large meteorites as they passed through the earth's upper atmosphere, and most of the collectors

out in the bush will give this explanation of their origin. While it is possible that a large meteorite (stony in composition) could have shed this material by air friction (ablation), nevertheless it doesn't seem likely that the several known areas of fall should all have been visited by meteorites so alike chemically. Whatever their origin, tektites are indeed a fascinating subject for study.

February 2, 1959:

Dr. Hininger was always up by 4:30 or 5:00 a.m. for a morning walk, but I usually managed to sleep until six. On this particular morning we were all up early to drive to the top of the hill back of Corregin and visit the laterite quarry. En route we saw many large green parrots, almost as large as pigeons, usually in flocks of a dozen or more. Though predominately green, they have yellow markings on the wings and head, as well as a touch of red. We also saw many smaller parrots, about the size of our sparrow hawk and with about the same coloring as the larger variety. They are very swift in flight and remind one of a falcon in flight except that they move in small flocks.

The laterite quarry was one of the most remarkable deposits of material that we saw anywhere in our travels. The quarry itself was about 30 feet deep and in the side of the hill with perhaps 15 feet of rise above it and as much below so that I estimated a total quarry face of 60 feet might have been developed. A hard ridge of consolidated laterite ran through the center of the hill but that on either side was soft enough to dig quite easily with a skip loader. The hill itself was about 200 yards long and about 100 feet higher than the granite dome it overlaid on the west. This was the only place where we saw a thick bed of laterite covering a granite dome.

After breakfast we headed south to other towns and locations where we had been told that australites might be purchased. About noon we

came to the wheat farm of a Mr. Clark who was reported to have a tektite collection. We parked in the shade of a tree to eat lunch and presently Mr. Clark walked out from the house (about 200 yards away) to find out who we were. He was very large around the middle, very bowlegged, very deaf, and wearing very ancient shorts and T-shirt. After much shouting and exhibiting of tektites, Dr. Nininger was able to make him understand what we wanted. He said that his sons had collected quite a few while disking and harrowing their fields in preparation for planting wheat, but that they were not home and he could not sell their belongings. This ended the conversation and he went back to the house; but while we were finishing our lunch he returned with seven very nice australites which he gave to Dr. Nininger. He wouldn't take any money, saying it was a donation to a scientific cause.

The farms in this particular area seemed quite productive. The stubble in the fields indicated that a good crop had been recently harvested, and the big new barns and new farm equipment indicated that crops had been good for a number of years.

We continued south, stopping in a town called Kondinin and at many farms along the way, but we found very few people at home. It seems that Monday and often Tuesday are bad days to find farmers at home, long weekends being the rule after the harvest season is over.

All of this country to the east of Perth was once covered with eucalyptus forest before it was cleared for wheat farming. There are still large sections in the natural state and most of the roads, which are laid out with the compass, are lined with the natural forest which has never been cut. The right-of-way is usually ~~about~~ 100 feet, but the graded roadway is only about 35 feet in width so that a nice strip of forest remains on either side providing welcome shade and improving the beauty of the landscape. Many of these wheat farmers seem to have had an eye for beauty and in clearing the

land they left some of the largest trees scattered over the fields.

As we continued south in the afternoon we began to notice large granite boulders scattered here and there and the underbrush began to show signs of increasing rainfall. The blackboys and other kinds of undergrowth made it impossible to see more than 100 feet or so into the bush, while farther to the north the forests had been entirely open. Late in the afternoon we came to a river, the first we had seen since leaving Perth, a distance of 486 miles, according to the Holden speedometer. This lack of rivers and streams (not even a tiny stream along the roadside) was a mystery to us. Roadside gutters and steeply sloping fields that would wash into deep gutters and gullies in the United States show absolutely no sign of erosion here in the land of laterite. The rainfall this far south is 15 to 18 inches, enough to grow thick forests with undergrowth and some trees as tall as 100 feet. In our own country where similar forests were cut and the land cleared, the erosion has been very severe. Here, even after the land is cleared of its natural protection and the land plowed to make it still more vulnerable, it does not erode.

Australian geologists have failed to see this unusual and anomalous condition or to realize that if present-day conditions of erosion and sedimentation were projected into the past as Lyell proposed,--there would be nothing to project. Nor can we point to any other locality in the world where this type of topography is being actively produced. To produce a plateau of 275,000 square miles, all of it about 1,000 feet above sea level and extending right up to the ocean, without interior drainage and only short rivers along the coast, yet with a continuous swell and swale topography and without gravel deposits to indicate where the material went that was eroded away (assuming it is the roots of mountains as the geologists say)--then I say it must

have been the devil himself with a very large clam-shell bucket who did the job.

February 3, 1959:

After spending the night in Katanning, a fair-sized town, we got an early start southward toward the Big Tree Country. At Cranbrook, about 50 miles south of Katanning, we drove seven miles out into the country to the east to find a man by the name of Scott who was said to have a collection of tektites. We finally found the place but his wife said he was down the road about two miles "biling". With these directions we began looking for someone baling hay, but after driving several miles and finding no such operation we concluded that Mr. Scott, who was a doctor by profession, had gone to visit a patient.

Cranbrook lies at the southwest end of the Stirling Range and the Scott farm was really in among the mountains. This range consists of a row of isolated peaks which rise above the plateau, the highest being Bluff Knoll, 3,640 feet in elevation. These peaks are quite sharply pointed but worn smooth by ice erosion of recent time.

As we neared the south coast, the forests became thicker and the streams had real running water in them, It was here that we saw our first dead kangaroo. Many kangaroos get hit by cars on the roads at night and most people who drive in the bush very much, have guards built on the bumper to prevent damage to headlights and radiator. We also saw and heard the famous laughing jackass birds-- the Kookaburra. These birds are about the size of a kingfisher and have much the same body build and manner of flight.

We did not go to Albany, largest town on the southwest coast, but took a short-cut by dirt road across one side of a triangle to reach a little town called Denmark. Here we had our first glimpse

of the southern ocean, an arm of a bay called Wilson Inlet, and on this bay our first and last sight of the famous black swans that are native to this region. They were at least a half-mile away but such large birds are seen quite easily through glasses at that distance. There were two large flocks and in the nearer one we counted 120 birds and estimated that the other flock was at least as large. The black swan is about the same size as the white swan of the northern hemisphere and every bit as beautiful and graceful. Now and then a bird would hoist his wings, stand up in the water, and shake out his feathers. When one did this we could see a white patch under each wing.

We had been passing through beautiful eucalyptus forest for some time, down a long straight road--a narrow canyon cut through the timber. The heavy forest grows on the steep front of the great plateau where it suddenly breaks off to the southern ocean. The moisture-laden air rises against this steep 1,000-foot wall, cools, and condenses as rainfall. The average rainfall is between 50 and 60 inches. The road was unusual in that it was perfectly straight but angled down the mountainside, crossing many deep canyons at an angle and producing a series of roller-coaster dips that were quite thrilling.

We turned off the main road at a place called Quarren to see the Valley of the Giants, a state park where some of the biggest trees are preserved. These trees are really huge and rugged, reminding one of the California sequoias with their massive trunks and gnarled and rugged tops. Some of them have had their bases burned out until cars can drive through. This grove of trees apparently covers no more than about 100 acres in a saddle between two low peaks. These trees appear to be much older than the rest of the forest which extends for about 200 miles along this south coast. We saw thousands upon thousands of trees in the general forest that were six to seven feet in diameter

and perhaps one in a thousand might reach eight feet, but here in the Valley of the Giants, many have reached a diameter of 12 to 15 feet.

All through this south-coast forest belt there are large sections of dead trees, bare white poles rising high above the underbrush and young trees that have sprouted. We were under the impression that forest fires were the cause but a pioneer citizen told us that English colonists after the first world war had girdled these trees to kill them so that the land could be cleared for farming. The job proved too great for all but a few, but the dead timber still stands as a monument to the majority.

Most of the lumber used in Australia comes from this section. We saw several sawmills at work and great piles of logs and bright red, freshly cut lumber. It looks very much like mahogany but is much harder. There are two varieties of the big trees, one a smooth-barked gum that sheds its bark in long streamers, called karri, and the other a rough-barked tree called jarrah. I was told that the karri must be sawed within two days after falling or it will split so badly that it is useless for lumber. They have lately invented a new method of driving the oil and sap out of the green wood by steam pressure. This hastens the drying and prevents splitting and checking.

We arrived at the town of Northcliffe about 8:00 p.m. and after dinner in the only hotel, we went out into the street to look at the stars. It was very dark except for a few lights in the hotel and the stars seemed unusually bright. We could make out the Southern Cross and the two great nebulae of the southern hemisphere called the Magellanic Clouds (M 31 and M33) which are closer and hence much brighter and larger than ours of the northern sky. These two great nebulae or galaxies (70,000 and 80,000 light years distant) are easily seen with the naked eye and field glasses. Other nebulae

which can be seen from the northern hemisphere too, are visible on the northern horizon. (Reference: Larasse Encyclopedia of Astronomy, Page 419). Smog is not a problem here: Nothing but 2,000 miles of ocean and 2,000 miles more of Antarctic ice between Northcliffe and the South Pole.

February 4, 1959:

We left Northcliffe Lodge at 7:30 a.m., driving through magnificent eucalyptus forest for miles and miles. We stopped many times to take pictures and to wonder at the towering trees. At one place we saw two parrots high in the treetops. So high they were, and so dark against the bright sky that they looked black as crows; they sounded like crows, too, but they had long tails and parrot wings.

I noticed that many of the big trees were growing on white sand dunes which had over-ridden the granite and laterite. The big trees always grow on the hills, the valleys being barren of any kind of trees apparently because of the high salt content in the ground water in the valleys. This is opposite to the growing habits of the California redwoods where the biggest trees are always found in the deep soil along the river banks. The salt-water bugaboo is everywhere present in Australia, whether in a section of heavy rainfall or in desert. We saw a few small swamps or lakes in this area but nothing unusual. As we turned north toward Perth the eucalyptus forests began to thin out and more farms and orchards appeared with towns popping up all along the way--such towns as Manjimump, Greenbushes, Wonnerup, Donnybrook, Boyanup, Harvey, Yarloop, Waroona, Goolup and Pinjarra. Near Goolup we came upon a roadside clay mine where they were digging out pure white kaolin of very fine quality. It could be ground between the teeth without feel of grit, a test which is said to be as good as any to determine the fineness of clay. In a stratum just above the clay and below the usual blanket of ironstone there were many crystals of black

tourmaline.

Nearing Perth, the road comes down off the plateau and follows the coastal plain for about 20 miles before reaching the city. This plain is two or three miles wide and 30 to 50 feet above sea level, its only unusual feature being a number of small lakes without outlets scattered along its length, a significant geologic fact we shall discuss later.

We arrived in Perth about 4:00 p.m. and I was able to drive on the left side of the street all the way through the city to our hotel. Quite an accomplishment I thought!

February 5, 1959:

We spent most of this day going to banks, shopping for a Volkswagon Combe and looking for camping equipment. We expected to spend about two weeks in a cross-country drive of some 2,500 miles, ending up at Adelaide on the south coast. We would swing north to Mallewa, thence east via Yalgoo^{oo} (from where we hoped to visit the Dalgara meteorite crater) to Mt. Magnet, then south to Kalgoorlie, Norseman and on across the Nullarbor to Adelaide. The last 1500 miles or so would be across the Nullarbor (the word means null arbor--"without trees"), and we expected to camp out most of the way. We were told that we would have to carry extra gas and water driving anywhere in this back country, and most people whom we asked thought we were crazy to try it at this time of year--summertime.

February 6, 1959:

My money did not show up from home but Dr. Nininger made a down-payment on the Volkswagon and we went to Boan's, the big department store where we bought camp cots, pads, sheets, thin cotton blankets, folding chairs, cooking utensils, water cans, spare gas cans, and many other items. This store in Perth is six stories high and covers a whole city block. It is truly a department store, selling anything one would want to buy, including groceries and meats. Everything

atlas. It would be necessary to go to the city library to get an atlas.

APPENDIX I.

The Canadian scientist have been doing some outstanding work in their search for large meteor craters in Canada, realizing as they do, that large scale meteorite collision might have had a vital part in the history of the earth and in the mineralization of the earths crust. This has included a search of aerial photographs of the whole of Canada including the arctic islands and the discovery of a whole series of circular depressions and lakes that may be of meteoritic origin.

The discovery of the New Quebec Crater in 1945 and its subsequent exploration by Dr. V. B. Meen of the Royal Ontario Museum of geology and Mineralogy in the summer of 1950 gave the initial impetus to the investigation that is still underway.

Dr. C. S. Beals, astronomer of the Dominion Observatory at Ottawa, has been directing the search and field studies as time has permitted. In 1956 the Dominion Observatory published a paper by C. S. Beals, G. M. Ferguson and A. Landou called "A Search for Analogies Between Lunar and Terrestrial Topography on Photographs of the Canadian Shield." Also a paper by P. L. Willmore and A. E. Schiedeggar on "Seismic Observations in the Gulf of St. Lawrence". This circular depression in the Gulf of St. Lawrence is filled with sediments to a depth of about 20,000 feet. A deep basin 207 miles in diameter in the granite of the Canadian Shield.

The writer has also learned from personal communication with Dr. Beals that they are investigating the Hudson Bay crater arc which is some 250 miles in diameter. This possible crater was first pointed out by Kelly & Dachiile, TARGET: EARTH, Page, 58, published in 1953.

The investigation of these very large craters may be the turning point in the acceptance of the collision theory of geology if the evidence proves beyond doubt that they are of collision origin. It is very difficult, of course, to dethrone a ruling theory that has been accepted in the highest halls of learning for 128 years, (since Lyell wrote his Principles of Geology in 1833) but this is surely going to happen.

Collision geology is the key of logic that opens the door. Each new anomaly is explained as it arises by cosmic collision. It requires no special brains or genius, anyone who understands the theory can apply it to any new geologic problem that cannot be explained by orthodox geology.

Turning to local questions of geology I asked about the origin of the granitic plains, the swell and swale topography. He had no knowledge of any theories of origin and was surprised to learn that there could be anything unusual about such a land surface. It had never occurred to him that any anomalous conditions prevailed.

I do not wish to seem over-critical of Australian scientists who do not know what is going on in Canada or the United States because I suspect that we in North America are just as ignorant of what goes on in Australia. Lack of communication works both ways, but it does not seem to me that the Bureau of Mines could afford a small map or a globe of the world. I have found in searching American universities and public libraries that we are woefully lacking in geological information on the lands down under, but it turns out to be almost as difficult to get such information when in Australia. I inquired in many different book stores in Fiji, in New Zealand, and in Australia for books on the local geology and was only able to find one in each of these lands. The one book on Australia is called **THE FACE OF AUSTRALIA** by Charles F. Laserson. It is written for the layman and includes a good deal of information on the plant and animal life of Australia. I would recommend it to a layman and geologist alike, as a well written and descriptive work, although I do not agree with most of his geological conclusions.

About two weeks later, while in Kalgoorlie, some members of the local Rotary Club responded to my request for more geological information and very kindly agreed to send me a copy of Geological Survey Bulletin No. 95, "The Physiography of Western Australia", along with a colored geological map of Western Australia. They had to send for this material themselves, so I did not receive it until sometime after returning home. Bulletin 95 is the third edition, first printed in 1934, and apparently the only geological information

available on Western Australia other than short papers published by individual geologists, chiefly on gold mining activities. Too many scientists I am convinced are interested only in the pay check.

Dr. Nininger had placed a notice in the Perth paper that he wished to buy tektites and a like announcement was made over the radio; quite a few people responded. From one of those who telephoned, the Niningers purchased quite a nice collection of tektites. In this collection was a long dumbbell-shaped australite with a thin feather edge extending lengthwise all around it.

Dr. Nininger and I got into quite an argument as to how it proceeded through the air to have produced this feather-edge flow pattern. He argued that it spun like a propeller and I insisted that it rolled slowly like a rolling pin, thus producing the waist at the middle and that the final position was one side on, so that the feather edge was formed where the frontal air flow met the reverse flow from the rear.

February 7, 1959:

Dr. Nininger went downtown early to get the maps we had ordered and to see an individual who had telephoned about tektites. I got busy on the telephone trying to find out why the money I had cabled for had not arrived. I had been calling the Bank of New South Wales who seemed to know nothing about my cable but were making every effort to find out about it. Finally it came out that there was another bank in Perth called The Bank of Australia and New South Wales which I had stumbled into when the thought occurred to me to send for money. I grabbed a taxi and rushed down to the bank just before 11 o'clock closing time, got my money, and went back to the Volkswagon agency for the Combie. Dr. Nininger was there, and after paying the bill and loading in the camping gear we took off for the Hotel Charles. Dr. Nininger rode with the agency owner, who piloted us to the hotel. He didn't seem to want to ride with me through the traffic in the new vehicle.

After lunch we loaded in the rest of our baggage and found there was just room enough for Mrs. Nininger to sit on an aluminum camp chair in the middle of the floor behind the front seat. It had arm rests and was a fairly comfortable chair. Later, when Dr. and Mrs. Nininger had changed places several times it was decided that this seat in the center of the Combie was less bouncy than the front seat.

Our way led north over a good paved road, once we got out into the country. Near the city it was very rough with deep chuck holes and washboard surface, the latter called corrugations in Australia. The weather had been very warm in Perth and we were all glad to get up onto the higher plateau. We stopped for the night in a little town called Dalaroo where we found lodging in the usual choice rooms, just over the bar.



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CHAPTER VIII

THE DALGARANGA METEORITE CRATER

February 8, 1959:

We were up early and off by 6:20 a.m. to the next town for breakfast. We had decided we would eat out and sleep in hotels while we could because camping might get a little tiresome before the month was out.

We began to get into the wheat country, the road paralleling the railroad, and about every 10 miles we passed a big wheat bin. The Australians do not use elevators but build long wooden bins to hold the wheat. The bins are V-shaped in cross-section so that the wheat will gravitate to the bottom as the bin is emptied, and some appear to be 400 or 500 feet long. Usually there are two of these bins. One is open to receive the new crop of wheat and the other has a roof for long-time storage.

The wheat country is the home of a beautiful parrot, a bird about the size of a pigeon with a rose-colored breast, pearl gray back, and some rose and white under the wings. We saw them by the hundreds around the open wheat bins, sometimes literally covering the bins. Like all parrots they are quite at home hanging by their beaks or upside down by their feet. Many were resting on the telephone wires along the railroad and about as many were upside down hanging by one foot, as were sitting upright. I asked a small boy what they called these parrots and he said "gahlah". After having him repeat the word several times, I asked him why, and he

answered, "because that's that they say--'gahlah-gahlah-gahlah'".
Sure enough, when I listened, that is what they did say.

In the afternoon we came out into more open country not far from the coast where huge sand dunes had grown into hills. A thick brush vegetation on these sand hills has produced a surface soil sufficient to grow good wheat. A little beyond we passed by the big Yarra Yarra lakes at Carnamah and on north to a town called Mingenew, where we turned eastward on a dirt road across to Morawa and thence 79 miles more to Yalgoo. During the day we counted four new kinds of parrots and were much surprised to find these large birds in semi-desert country where water is very scarce. Most of the birds are seen around windmills and watering troughs. We saw big black parrots--birds at least two feet long, half of which is tail. When they fly and spread the tail a large patch of deep crimson appears on the underside. We saw two other varieties of rose-breasted parrots as well as a white parrot with a sulphur-colored head and breast.

We reached Yalgoo about 5:00 p.m. and got rooms at the Railroad hotel. Yalgoo is the central town in a large county or Road District, and was once a thriving gold-mining area. Most of the mines are now abandoned and Yalgoo has gone back to a population of about 25 people, three times that many dogs, and some roosters. In the middle of the night the dingoes came to see about the roosters and all the dogs rushed forth to do battle with much barking and minor squabbling among themselves. This went on intermittently until near morning when the roosters came to life and began to crow. It reminded me of old-times at home on the farm, and when a few burros joined the sunrise chorus with some choice braying, the sounds were those of a little Arizona mining town, which made the Niningers feel right at home.

Yalgoo was laid out with a 100-foot-wide main street that stretched up the slope from the railroad station. In later years the railroad was moved a bit and now the station is a half-mile from the hotel, the store a little beyond, and the garage just beyond that, with a half-dozen houses lining the rest of the street. Old walls and piles of brick rubble indicate the glory that was once Yalgoo.

The hotel had the inevitable saloon in front and a long hall extending to the back with a kitchen and dining room on one side and the bedrooms on the other, each bedroom having a door out onto a long porch. The hotel owner invited us to move our bedding out onto wire cots that lined the porch from end to end. Dr. Nininger and I took advantage of this offer, but Mrs. Nininger, being a lady, stayed inside and suffered the 100-degree temperature all night.

February 9, 1959:

By 6:15 a.m. we were under way, headed for Mr. Ross's sheep ranch, called Dalgaranga Station, about 60 miles north and east of Yalgoo. The road was rough and full of pot holes and corrugations, but the farther we went the better the road became, apparently because of little traffic. Much of it was as smooth and hard as pavement and straight for miles. We saw our first wild kangaroos just a few miles out of town, and then three emus, the huge flightless birds of Australia, crossed the road.

We continued on over endless straight road through scrub bush about 12 feet high. We could never see more than about 50 yards into the bush. Arrived at last at Dalgaranga Station where we were met by Mrs. Ross and two friendly sheep dogs. She had no idea we were coming, but she was very hospitable and invited us in for a round of ice-cold beer.

Dalgaranga Station is an old one and has seen years of great

prosperity when wool was high. The house is old but large and well made, and filled with expensive furniture of vintage 1880. It was very dark inside, the curtains being drawn to keep out the heat, but after a few minutes were able to see each other and to enjoy the coolness of a well insulated room. Mrs. Ross said she had come here as a bride 30 years before when her husband had bought the station lease. The station contains 264,000 acres and was named after the peak we could see to the northeast, Dalgaranger Peak, a mountain that appeared to be at least 1,000 feet higher than the surrounding plain. She told us that a spring on the side of this mountain was the only natural flowing water for 100 miles in any direction. Just a few hundred yards to the rear of the house and other outbuildings, a large granite dome stood above the plain. On top, she said, was a lake of several acres which had been dammed off by a low wall which we could see from where we stood. This was their main water supply when rainfall was sufficient, but they had a "dug well" in the yard which produced discolored, brackish water, and the inevitable rainwater tanks which are seen around every house in interior Australia.

Dr. Mininger told Mrs. Ross of our hope to visit the Dalgararga meteorite crater and inquired about the road getting there. She said she had never been there and could not direct us to it, but that if we wanted to drive out into the bush she could direct us to where her husband and the "blackfellow" were working on a windmill. They could show us the way. So, after getting directions from one windmill, to the next windmill, to the next windmill, and right and left turns, we started out.

We went around the big granite dome and took off into the bush. The bush is 15 feet high, so you can't see out of it to keep landmarks in view. My directions were mixed, even when I was at the

station and could see Dalgaranger Peak and the granite dome, so when we got into the bush and couldn't see these landmarks, I was completely lost.

After about 10 miles of driving we came to a windmill where we thought Mr. Ross should be but there was no sign of him nor his tracks; so we went back the way we had come for more directions. Mrs. Ross said we had not gone far enough, that there was one more windmill to go and the reason we had not seen tracks was that the men had probably taken a shortcut. She gave us more directions for finding the shortcut and told us to look for fresh tracks turning that way before taking it. "You never know about men. They may not go where they say they are going". She said.

We started out again, found the cut-off and the tracks and, in a remarkably short time, the windmill; Mr. Ross and the boy were eating lunch under a scrub acacia. Mr. Ross was a tall thin man of about 60 years whose hair had once been red. He wore a large "ten-gallon" hat with a wide brim to protect his tender skin, and kept his shirt collar turned up to protect against the bush flies. When he learned that we wanted to visit the crater, he said he had only been there twice, a long time ago, but that the boy could show us where it was. They would lead the way and we could follow. Mr. Ross said it was about 14 miles from where we were but it seemed nearer 20; most of it a straight road along a fence line.

We finally reached a group of big granite boulders where the boy stopped his truck and told us we would have to walk the rest of the way. We walked about 1,000 feet through scrub brush growing in desert pavement when we suddenly came to a hole in the ground. This was the Dalgaranga Meteorite crater which had been reported in scientific literature some 25 years before by the curator of the museum in Perth. He had not seen the crater himself but had assayed

the samples of iron brought in and reported what the discoverer said about its size and depth. It was reported as 75 yards in diameter and about 40 feet deep. It actually measured 75 feet in diameter and was 10 feet deep. Dr. Nininger was the first scientist to visit this crater and we were probably about the fourth or fifth white party to see it.

We looked for meteorites for about 30 minutes but didn't find any. Then Mr. Ross and the aborigine went home and we brought the Volkswagon out through the bush to the rim of the crater where we made camp. We hunted for meteorites all the rest of the afternoon and I found six, the biggest about an inch across. Mrs. Nininger found two or three and Dr. Nininger found several small ones. He had a horse-shoe magnet bolted onto the end of an aluminum tube so that he could rake around in the soil and pick up anything that might cling to the magnet. About half of the ground-surface around the crater was covered with small rusty-colored stones averaging about one-half inch in diameter. They are rough and sculptured in many cases and look almost exactly like the small iron meteorites which are among them. This makes the meteorites extremely hard to find and much time was spent in examining things that turned out to be stones instead of meteorites. It was very hot, over 100 degrees we guessed, and the bush flies were something awful. We stuffed handkerchiefs under our hats to cover our ears and the backs of our necks, but the flies were in our eyes behind our glasses and a constant annoyance.

We had a watermelon break about mid-afternoon and then back to hunting until dark. Mrs. Nininger got some supper out of the cans and all hands turned in for the night--but not before making a semi-scientific meteorite count did we drop off to dreamland. Dr. Nininger is a dedicated scientist who never stops work from dawn until dark,

except to eat, and that he can do six times a day.

February 10, 1959:

We were up early and Dr. Nininger started to search for meteorites with his big magnet. He didn't have much luck so he tried out the mine detector he had brought along from the States. We couldn't make it work. It was supposed to squeal when the plate was held a few inches above a piece of iron, but we couldn't get a sound out of it even on the biggest pieces of meteorite we had found.

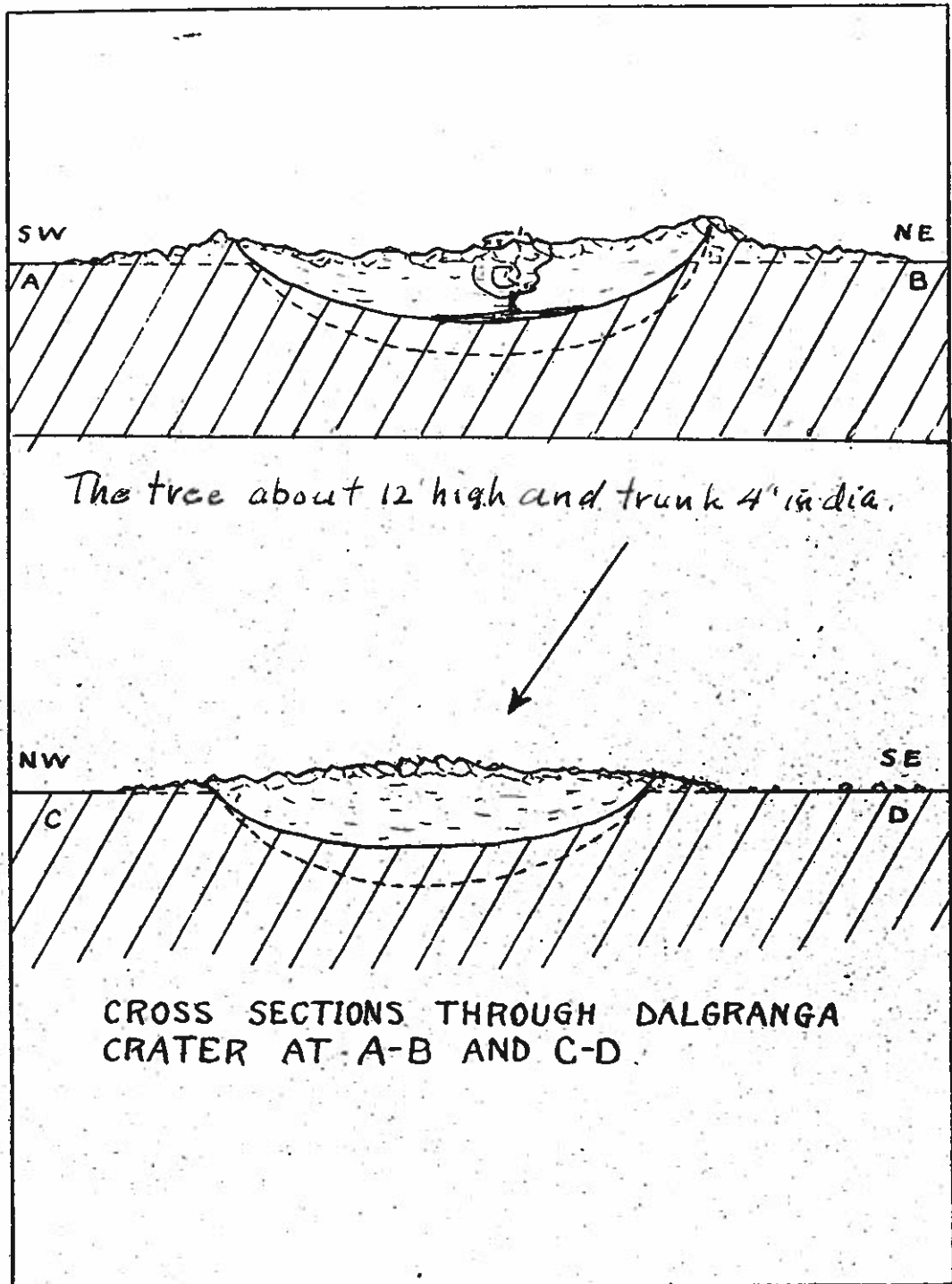
I tried the hand magnet for awhile but decided I could find more by looking. Mrs. Nininger and I each had a little magnet on a string so that we could test likely looking objects without bending over. This was a great help and I collected a few small bits by dragging the magnet behind me.

During the morning I took pictures and we measured the crater with a string. There was a good-sized tree growing right in the center of the crater making it impossible to stretch the string tight. I climbed the tree and cut or broke enough branches out so that we could stretch the string and get an accurate measure of the depth and diameter of the crater.

The Daigaranga crater is in perfectly flat ground in a granite formation with about three feet of laterite on the surface. The explosion upon impact threw up a rim of laterite boulders about five feet high on one side and perhaps four on the other side, and sloping down and outwardly from the rim about 15 yards at maximum points. The debris is not evenly distributed about the crater. Apparently the meteorite came in at an angle of about 45 degrees from the south-southeast and much of the force of the explosion was back in that direction for it cleared that section of the rim of all loose rock debris and hurled most of it a considerable distance out into the bush, most of it from 80 to 100 yards. Another streamer of fragments

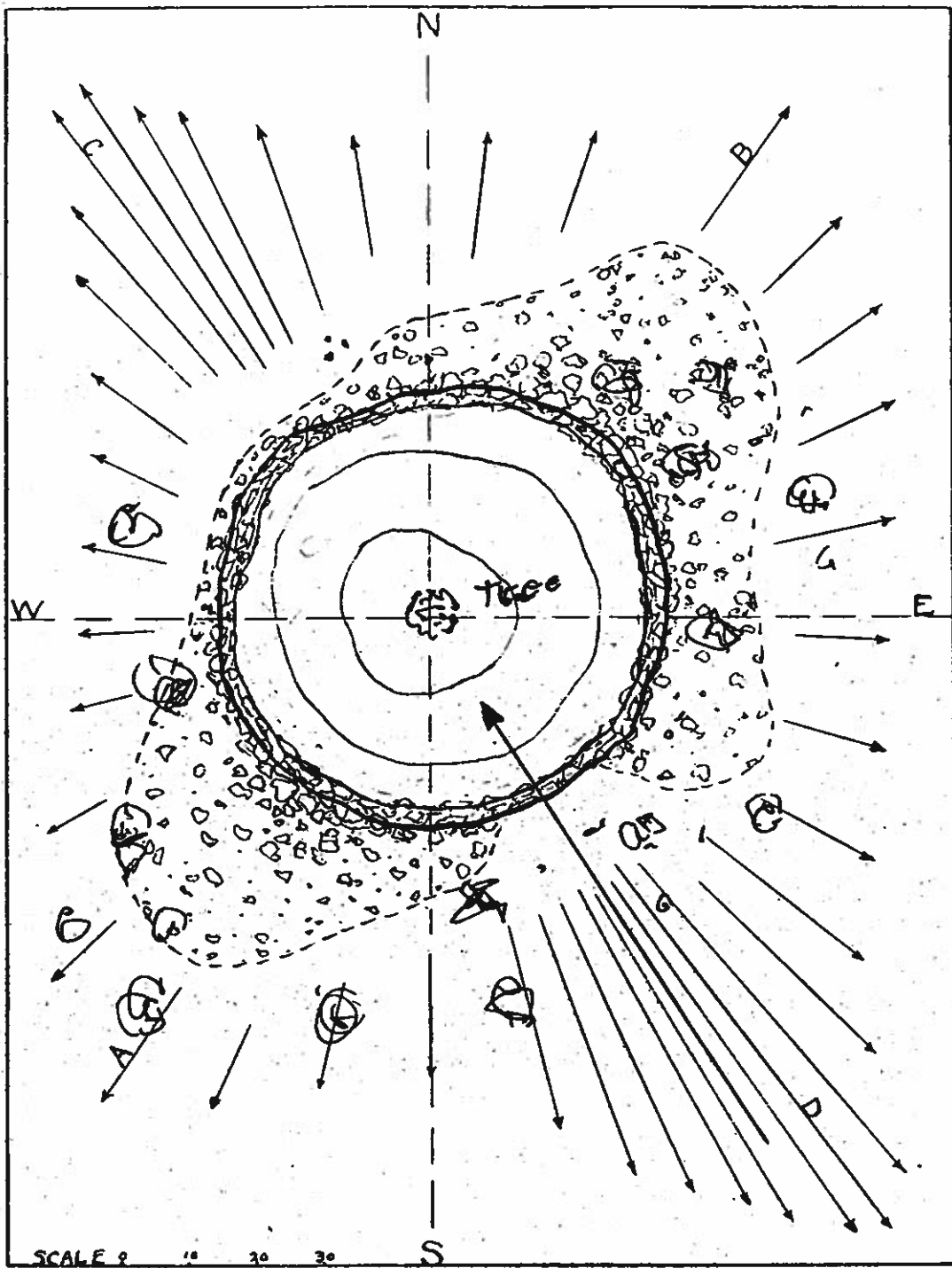
was thrown in the opposite direction, to the northwest, some as much as 200 yards and one chunk of laterite about 8 inches in diameter was 185 yards from the crater rim. There were other smaller streamers of rock debris but the main bulk of the material thrown out was close to the rim on the northeast and southwest sides. (See Fig. 17) I made a complete circle around the crater at a distance of about 80 yards where the largest chunks of laterite were to be found (about 18 inches in diameter) in the hope of finding a large meteorite but had no luck. I did find many pieces of flint that had been flaked by the aborigine. It occurred to me that perhaps the natives had traded artifacts with their gods, putting down a flint where they had picked up a piece of iron meteorite. This, I thought, might account for the small amount of irons as compared to the size of the crater. To test my theory I made a search far out beyond the last piece of laterite ejectamenta and found no sign of either flint stones or flaked flints. Flint does not occur naturally in granite country so the natives must have carried them there and besides, only man can flake a hard stone like flint. No doubt the natives saw this fall, for it would have been visible at a great distance even in daylight. They soon found the sharp little iron meteorites and carried most of them away, not forgetting to leave an exchange gift for the fiery god who came out of the sky.

Judging by the lack of weathering and erosion in the crater walls and in the laterite and granite thrown out of the crater, I doubt that this event occurred more than a few hundred years ago. Laterite, being a loosely cemented conglomeration of small pellets, it is not a stone that can be expected to withstand decomposition yet many of the chunks of laterite were quite fresh in appearance and even a stone 16 inches in diameter which I turned over, was only buried about three inches. The desert floor about the crater is extremely flat and quite



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PLAN VIEW OF DALGRANGA CRATER SHOWING THE IRRIGULAR DISTRIBUTION OF ROCK DEBRIS AND THE DIRECTION OF METEORITE APPROACH. ARROWS INDICATE CHUNKS OF LATERITE THROWN TO A CONSIDERABLE DISTANCE AWAY FROM RIM



had been overhead, giving no clue as to which was east or west. If we had seen Mt. Dalgaranger from the station early in the morning or evening, we would have known whether it was east, west, north, or south of the station.

We took the left fork, driving through the bush for what seemed hours, always along fences, for they build the road when they build the fence. We came to other windmills which looked strange but didn't dare go back because we were nearly out of gas. Finally the engine did stop and I turned on the spare tank which meant that we had 35 miles left in the Volkswagon. Only a few miles beyond we made a turn and looming ahead was the big granite rock by the station. Rarely have I seen a more welcome sight!

We were soon back at Dalgaranga Station and Mrs. Ross had us in for another round of beer. We had taken the wrong road at the fork, but had got onto another shortcut which brought us back safely.

We borrowed some gasoline from Mrs. Ross (we were to pay for it to her account in Yalgoo) and headed back for that metropolis. On the way we had a race with a pair of emus which were standing at the edge of a clearing about 150 yards from the road. They started to move and I drove off the road a little way daring them to race. Sure enough, they took the dare. Instead of disappearing into the bush, they started a 200-yard dash to cross in front of us. I slowed down just enough so that they could make it at full speed. They passed only about 50 feet in front of the car doing above 40 miles an hour. Their mouths were open, their necks stretched out, and their tails were bobbing up and down as they took 10-foot strides in their flight.

On our way out to find Mr. Ross the day before we had had a similar experience with another emu. This one had been drinking at a water trough when we arrived. ^{He} We started to run along a fence leading away from the water trough; we were on one side of the fence,

the emu on the other. At any point he could have turned away from the fence and into the bush but he was determined to cross in front of us. The road was smooth and straight and I kept increasing the speed until we were doing about 30 miles an hour, the emu just ahead of us about 20 feet. We had gone about a half-mile when I decided to get a picture. Dr. Nininger held the steering wheel while I tried to hold the camera out the window. Just then the emu tried to jump through the fence but rebounded off the wire about 40 feet, so that he was to the side of the car where I got two good pictures. Determined as ever he headed back for the fence, but I slowed down taking pity on the poor stupid creature. With no competition his judgment got the better of his instinct and he turned away into the bush.

Many years ago Roy Chapman Andrews told of his experiences in his explorations of Outer Mongolia. They had chased the wild asses and antelopes on the dry lakes of that country in their Dodge touring cars and the animals had raced them for miles in order to outrun and pass ahead of them. He thought that probably all wild animals which protect themselves by fleeing have this instinct to outrun and cross in front of their enemies. In my younger days, I had occasion to try out this theory several times on horses, chasing them in a Model-T Ford. In the spring of the year when the grass is green and the horses are feeling good, the whole herd will try to outrun your car and pass across in front of it. The old mares and geldings will trail behind but the colts and young horses will run 35 miles an hour quite easily and do better than 40 if pressed hard.

The Australian method of sheep raising, as we were told about it at the Dalgaranga Station, is quite simple. No extra labor is required except at shearing time. The land is divided up into large pastures, and at the corners where four pastures come together a well is dug and a windmill and large tank erected. Four watering troughs are set up, one in each pasture. Around the trough and in the corner of each -156-

pasture, a wire corral is built with a gate in one corner. When the owner wishes to "muster" the sheep in any given pasture, he simply shuts off the water in the trough until all of the thirsty sheep are in the corral bleating for water. This may take a day or two, but they all eventually come in. This is probably the only practical way to gather 200 or 300 sheep from a 20,000-acre pasture, when you consider that a man on horseback can only see a few hundred yards through the bush at most.

The only natural enemies the sheep have are dingoes, the native wild dog, and domestic dogs turned sheep killers. Every sheepman carries a rifle in his car and all dogs found in his pasture are shot unless accompanied by their master. To keep the wild dogs down the government employs hunters who do nothing but hunt and trap wild dogs. They are called "doggers" and their method of hunting is by jeep, motorcycle, and shotgun. The dogger puts a light motorcycle in the back of his Land Rover and takes off across the open desert or through the bush until he finds a good hunting ground. There he parks the jeep and starts after the dingoes on the motorcycle armed with a shot gun loaded with buckshot.

In this region we had our first look at the government rabbit proof fence. It is well built wire netting fence about five feet high and extending below ground surface six inches to a foot to keep the rabbits from digging under. This particular section of the fence is an east and west fence to keep the rabbits from migrating down into the grain farming country from the north. It joins the main north and south fence at a point about 100 miles north of Sandstone. These rabbit fences are an important feature shown on every road map for they extend for hundreds of miles across the country, actually fencing the rabbits off in a huge pasture that includes the whole northwest corner of Australia. We saw a crew of government repair men on the Dalgara

Station who were fixing a small section of fence that had washed out in a creek bed. Dalgaringa Station is on the headwaters of one of the small coastal rivers.

We reached Yalgoo about 5:00 p.m. and put up at the same hotel for another night of barking, braying, and crowing.

February 12, 1959:

We took off this morning for Mt. Magnet, Sandstone, Agnew and all points east. The road was dirt and badly corrugated but we had heard that Mt. Magnet was a big town with all facilities. The Volkswagon people in Perth had told us that we could get parts there and have our Combe serviced. When we arrived we found one old garage, a few stores and a court house. The main street was three blocks long and 100 feet wide. It began abruptly and ended abruptly in the desert. From either end of this street the tourist can see 20 miles without the view being interrupted by a house. The one touch of modernization was a curbed parkway down the center of the street with newly planted grass and some tiny wisps of trees.

The garage man had no speedometer cable that would fit a Volkswagon so we filled our gas tank and headed for Sandstone. The cable had broken for no apparent reason just before we reached Yalgoo so we were without speedometer until we reached Kalgoorlie, a distance of about 450 miles.

A little way out of Yalgoo we had passed out of the laterite and had come into a greenstone and quartz formation. Little quartz buttes were scattered all over the landscape, most of the surface rock weathered and split into angular chunks two or three inches on a side. The flats of desert pavement in between these buttes were covered with small blue-black stones that looked as if they had been varnished. The astonishing thing was the uniformity of their size and the steady change to larger and larger sizes. At first they were all half-inch size,

then an inch, two inches, and finally whole fields or flats covered with these black stones averaging about three inches in diameter. Then they suddenly ceased altogether and we entered a country of low bluffs and cut banks of red decomposed granite and pyrophyllite, the latter being an advanced stage of decomposition in granite similar to a very smooth clay. This part of the country is the same rolling topography as described earlier except that the slopes are longer and more gentle. We had been gaining altitude all the way to Sandstone but so gradually it was hardly noticeable.

Sandstone is an old mining town with the regulation 1890 hotel, bar and gas pump, and tumbled-down garage with a few old junked cars. Also a road maintenance station, general store, and a few homes for those who must live in this dreary place.

Like most of these mining towns, Sandstone is on top of a mountain, better described as the highest part of a plain. From the hotel we looked down a long slope to the north that gave one the impression of looking into eternity--so vast, so far away from everywhere, and so uninhabited. There was not a sign of smoke from a farmhouse; just the blue of the brush-covered land fading softly into the blue of the sky. The air was very clear and we must have been looking at least 100 miles to the horizon. The town of Sandstone would do well to import a few of the sandstone cliffs from Dr. Nininger's home town of Sedona, Arizona, to place on that horizon. As far as I could see there was not a smidgein of sandstone in sight. My notes read, "Sandstone is sans sandstone^v."

We continued on toward Agnew, stopping about 5:30 at a sheep station to get water. We were met by barking sheep dogs and presently the owner came out from somewhere, dressed only in a pair of kakhi shorts. He kindly filled our water bags from one of his five big rainwater tanks. We asked him how many sheep he had and he replied that he was

running about 600 head on 303,000 acres, that being all he had fenced at the time. He said that was too many and that he intended to cut down to about 500 head. We had seen a few very wild sheep run across the road. Since they don't herd their sheep but only muster them twice a year for shearing, the sheep become almost as wild as the wild game.

I asked our host about the average rainfall and he said it was about 16 inches but that they had just had a series of dry years. Ground water, he said, was only six to eight feet down, but when one went much deeper it became salt water. It was in this area that we began noticing how the trees only lived to a certain age and he confirmed our guess as to the reason: When the trees reach a certain size the roots get down to salt water and they die. The dead trees are only about 15 feet high and the younger trees appear as healthy as any tree could be, with bright, lush foliage.

We camped that night in the middle of the road and about 50 yards from a windmill and trough, hoping to see wild game in the early morning at the water. It turned out that the only wild game was mosquitos, so we built a big fire of mulga wood and threw on green weeds to make a smoke. It was effective while the green weeds lasted, but that wasn't long. I made my bed (cot) in the road in front of the car, that being the place most free from stickers which might get into bare feet. There wasn't much danger from passing cars; we had passed only two cars all day, not counting those parked in Sandstone and Mt. Magnet. It had been threatening to storm as we went to bed and later in the night we heard thunder and toward morning big drops began to fall. So, like the characters of Biblical record, "We arose while it was yet night and departed from that place" ✓

February 13, 1959:

The early start was profitable, however, for we saw 30 kangaroos -160-

and three emus in the first hour. We reached Agnew quite early (85 miles from Sandstone) and found it just like its neighbor. We stopped at the hotel for gas and while I was hunting up the manager to pump the gas, Dr. Nininger went into the pub to see what he could find out about local tektite collectors. The gas station consisted of about 50 barrels of petrol, some full, some empty, standing in the yard. The manager broke open a new one and thrust a gas pump in the bunghole, pumped a five-gallon can full and then poured that in my tank. When this was accomplished I went around to the pub to find Dr. Nininger. He was busy drinking beer with a couple of customers and the bartender, trying to get some scientific information about australites. It should be said here that Dr. Nininger is definitely not a drinking man; he hates beer. But in the interest of science, he drank literally quarts of the stuff. The two Aussies had either started early or late the night before, because they were in no condition to give out accurate information. Dr. Nininger got me into the conversation and while they weren't looking he set the half-empty glass behind something and sneaked out the door. The gentlemen bought me a beer and then I had to return the favor, so it was some time before we got on the road again.

We kept close watch for kangaroos as we drove, because the dirt road had narrowed down to just one track and the bush on either side was quite thick. The kangaroos sleep in the shade of a bush during the middle of the day and if they chance to be asleep under one by the side of the road as you approach, they may dash in front of your car.

About 10 miles east of Agnew we crossed the Depot Range, according to our map. Actually, what we did was to go around the end of a ridge about 150 feet high and 10 miles long. It is hard to get adjusted to these Australian "mountain ranges" ✓✓

At Agnew we turned southeast and headed for Leonora, 83 miles away

with no gas stations between. We saw five emus in a group but could not get them to race, so decided they must not race on Thursday. We also saw seven wedge-tailed eagles eating a kangaroo someone had run over, two rabbits, a fox, and a dingo. The rabbits were certainly scarce; these were the first we had seen. But kangaroos are more plentiful than rabbits would be along our country roads at home.

Leonora turned out to be quite a nice little town, more buildings than we had seen in any town since leaving the coastal area and quite apparently a trading center for the mining industry. Just before entering the town we came upon the largest aborigine camp we had yet seen. Scattered over a few acres of ground along the roadway were about 20 rude shelters, most of them constructed of old burlap sacks and bits of canvas thrown over bushes to provide a shade in the heat of the day and some shelter from the dew at nightfall. One old blackfellow sitting under a bush had most of his upper body painted with white spots but he quickly put on his shirt when he saw that we were going to stop.

Dr. Nininger had found that nearly all of the natives knew about tektites (they call them meteorites) and have collected them for many years. He began to circulate about the camp showing them a few tektites he carried in his pocket and asking if they had any for sale. He finally found one man who sold him two. Others said that they knew where many could be found but the sites were far away, several days travel. Some said that in years gone by they had collected many, hoping to sell them to the museums or white collectors, but that the demand had ceased long ago and that they had lost or thrown away what they had had.

One fierce-looking old man came up to the car and begged for money so I gave him a shilling for the privilege of taking his picture.

He had a dirty rag tied around his head to keep the hair out of his eyes and a tattered shirt and pants about the same color as his skin. A few specks of white paint remained on his face and chest from a recent paint job that had mostly worn away, and he had the usual ring of flies around his eyes and at the corners of his mouth. The aborigines never fight the flies away but allow them to sit and drink the moisture from their eyes and mouth. Extra flies, waiting their turn, sit on their hosts' backs in considerable swarms.

The Australian aborigines are a very primitive-looking people, many of them with very heavy, gorilla-like features, but they do not impress one as a fierce or aggressive people. They never crowd around your car to see what you may have inside nor do they give the impression that they might steal something if left unwatched. This is generally true in all parts of Australia and New Zealand where honesty is well above the world average. The foreign sections of the big cities are probably not much better than the under-privileged sections of most big cities, but the native population has, by and large, a better-than-average record for honesty.

We saw a good many half-castes in the country towns and learned that they are a product of pioneer days when there ~~was~~^{were} no laws against the inter-marriage of white and black races. Many of these half-castes have apparently married other half-castes and the genetic result is often a person whose skin, eyes, and hair are a uniform shade of brown best described as a milk-chocolate color. In talking with a number of Australians about this peculiar coloration, I was told that the brown or cinnamon-colored hair is a characteristic of the pure-blooded aborigine, not just the half-caste. Later, around Alice Springs, I saw many natives who, though very black of skin, had quite brown hair.

We ate lunch in Leonora in a little cafe where we had "stike and iggs" (steak and eggs). We asked for water but none was available,

probably because Leonora is in a very dry desert country and entirely surrounded by dry salt lakes. Any ground water produced would no doubt be salty. "Lolly water" (a soft drink of any kind) and beer are always available, and sometimes milk.

A few miles south of Leonora we crossed over Lake Raeside, an ephemeral body of water that consisted of a salt flat about two miles wide and 115 miles long. There are a number of these string lakes in this vicinity which are thought to be the remains of an ancient river system that has been cut into short lengths by encroaching sand dunes. I saw no physical evidence to bear this out but we crossed at right angles and so had little chance to see much of the shoreline.

We continued for 65 miles across a flat salt⁺ desert country to the old mining town of Menzies, which, like all the other gold-mining towns in Australia, is located on a greenstone intrusion a few hundred feet above the surrounding country. Menzies is truly a ghost town. Perhaps a dozen old buildings stand along a wide main street, many of them with the windows out and the roofs fallen in. One I remember well had four Greek half-columns in the front wall and a formal Greek doorway and roofline. With the roof fallen in and the back wall knocked out, it looked for all the world like an ancient Greek temple. It was probably the bank of Menzies in its heyday.

According to our map it was 82 miles from Menzies to Kalgoorlie, but night overtook us before we could reach the city so we camped out near a place called Broad Arrow, which was a one-building station on the railroad.

During the last hour before reaching Broad Arrow we had been climbing quite steadily, a long straight road that seemed to rise in steps, each one a little higher and steeper than the last. The eucalyptus forest was increasing in height and density too and it was quite

obvious that the rainfall here was considerably greater than on the lower plains. The larger trees were about 75 feet tall and scattered out, tending to grow in little clumps with open spaces between covered with a gray brush two to three feet tall.

We drove off the road about 100 yards and camped near some beautiful salmon-bark gums, a eucalyptus with a salmon-colored, satin-smooth bark which, in the younger trees, sometimes changes to a rich olive green on the shady side of the tree. This tree sheds its bark in long streamers which hang from the main trunk in strips as much as 10 feet in length and add considerable picturesqueness to an already beautiful tree. A chill evening wind was blowing the streamers as we made camp and rustled firewood for the evening meal. There was no lack of wood here in this forest of Magos, the native name for these trees.

The elevation must have been close to 2,000 feet at this camp for we traveled downhill for many miles the next morning before reaching Kalgoorlie, which is ^{at sea level,} 1,250 feet high. We put on all the clothing we had and went to bed early but could not sleep because of the cold. Dr. Nininger got up about 3:00 a.m. and gave all of his bedding to Mrs. Nininger to keep her warm. He built up the fire and I got up, too, after another hour; it seemed like a good time to look at Jupiter's moons with my Questar telescope. The seeing was really wonderful and we could count five moons quite easily.

February 14, 1959:

After an early breakfast we got away from camp about 7:30, driving 25 miles down to Kalgoorlie. We found the Palace Hotel without much trouble at the main intersection in town and also some very welcome mail at the desk. I received two letters from Mrs. Kelly, one from Honolulu and the other after she had reached home, so knew that she was safe and sound.

CHAPTER IXKALGOORLIE TO ESPERANCE AND THE RIDDLE OF THE DRY LAKES

I took our combi to the Volkswagon agency for our 1,500 mile checkup and they ordered a new speedometer cable from Perth. It arrived the same day, by air--an amazing bit of service!

Kalgoorlie is a city of 22,000 people and apparently very progressive. It is the second largest gold-producing area in the world, being surpassed only by South Africa. As we had seen, Western Australia is dotted with old gold-mining towns but Kalgoorlie is the only steady producer left. Its main street is called the Golden Mile. It is about a mile long and at its end many roads fan out over the "golden hill", an area of several hundred acres that is literally covered with big stamp mills, smoke stacks, and mine elevator shaft heads. Beyond, in a valley, are dozens of big mesas of "mill tailings" where the slurry from the stamp mills is pumped out to dry after the gold has been extracted. Some of these big tailing piles cover as much as 20 acres and are over 100 feet high. They are big square mesas surrounded by a rim, or dam about two feet high made up of old cement sacks full of mud. As the mud settles out of the water and raises the floor of this hilltop lake, the dam around the edge is raised from time to time by laying on another tier of cement sacks. It seems almost incredible that so much dirt and rock could have been removed from beneath this hill. Many of the old mines have caved in or have been "worked out" and whereas there were once over 30 separate mining companies at work here there are five now and they are trying to consolidate into three or four.

I visited the School of Mines in Kalgoorlie where I was told

I should go to see ~~Mr. Campbell~~ ~~who was~~ the mining engineer in charge of one of the big mines. This I did, and after a long and pleasant chat I was invited to go down in one of the mines the next day.

Mr. Campbell told me that all of the ground water around Kalgoorlie ^{is} ~~was~~ salty; even 3,000 feet down in the bottom of the mines it is almost as salty as the ocean. He told me the story of how one of the early pioneer mining engineers had spearheaded the drive to bring fresh water from the coast near Perth, 348 miles away, and how this wise benefactor was abused and condemned by most of the people until the day of his death as a waster of public funds and a scoundrel. This pipeline, which we crossed several times, is laid above ground on cement piers which take the thrust of pumping and give it a long life which it would not have if buried underground in strong chlorides. Mr. Campbell said that the ground water farther north (where we had just come from) was fresh; strangely he had not heard that the water just beneath this surface layer was also salty. I told him of my theory that all of Western Australia and probably most of the continent was ancient sea bottom that had once been the bottom of the deep ocean and that the presence of salt water deep in the mines indicated that this was true, the terrific pressure of the deep sea having driven the salts far into the fractures of the earth. He considered this theory without committing himself and went on to tell me that the oxidized or decomposed surface rarely exceed^s/200 feet in thickness and in most areas, far less. Also, that except for a few isolated peaks, no land in Western Australia is higher than 1,500 feet and most of it is between 100 and 1,200 feet in elevation. Every gold mine in Western Australia, he said, is on or by a mountain and all the gold is found in the greenstone. The greenstone is geologically younger than the granite, having intruded the granite as dykes, but it also weathers

more slowly and thus forms the ridges and low mountains that ^{carry} ~~carries~~ the gold. (See Bulletin No. 95, Geological Survey of Western Australia, Page 316). I asked about the large dykes and veins of quartz that I had seen farther north around Sandstone and he told me that in Western Australia quartz is always barren of gold.

In the afternoon, I went to the Bank of New South Wales to cash a check and met the manager of the bank, ~~Mr. Haigh~~, who ^I found to be a fellow Rotarian. He expressed a strong interest in our scientific expedition into Western Australia and asked if I would speak at the Rotary luncheon on the following Monday. I agreed and got a spot on the program for Dr. Nininger too. Dr. Nininger, in the meantime, had met ~~Mr. Compton~~, a retired mining engineer who had taught geology in the local School of Mines for 30 years. He invited us out to his home that evening to see his collection of gold specimens and his collection of tektites, or so we thought. It turned out that he kept the tektites downtown at his club but we did enjoy their company very much and their hospitality. ^{His home-grown} Fresh grapes and figs were his pride and joy.

February 15, 1959:

Mr. Compton and his son came down to the hotel about 10:30 a.m. and Dr. Nininger went with Mr. Compton to his club where they were to sort out some 38 specimens of tektites which Dr. Nininger hoped to purchase. The younger Compton is a geologist for one of the big mining companies at Kalgoorlie. We two sat in the hotel lobby and talked geology until nearly noon. He was very much interested in the collision theory and I gave him one of the books I had brought along. He complained because neither the mining companies nor the government would spend any money for exploration beyond the immediate vicinity of the mines. He said that nothing was known of the structure five miles

away from Kalgoorlie. We talked about the origin and migration theory of lakes, the swell and swale topography-ocean bottom theory, and I explained to him Dache's precipitation theory: (See TARGET:EARTH-The Genesis of Minerals, pages 202-207) how the elements might have rained down from a collision cloud. I could see that most of this seemed too fantastic for him to believe but he did agree that most of Australia was old ocean bottom. He had long held to this theory himself although he said it was not generally accepted among geologists in Australia.

Dr. Nininger had given the word to the press and announced over the radio that he was interested in acquiring tektites and by that afternoon we began to get results. Several people brought their collections, some willing to give them for the sake of science, some wanting to sell. One young man named Smith, who had quite a nice collection, gave me five tektites, one of each of the several varieties of shapes found in Australia.

Later in the afternoon we went to visit Johnnie Carlisle, known locally as "the Dogger" who lived on the outskirts of town. He was a government hunter who had charge of reducing the numbers of dingoes which are so destructive to sheep in Australia. His job consists of traveling all over Western Australia for several hundred miles in all directions from Kalgoorlie hunting wild dogs. His equipment consisted of two Land Rover^s on which he carried two light-weight motorcycles. With this equipment, he and a couple of helpers, one a cook and the other a hunter, travel out through the desert to the hunting grounds. They make camp and the hunters take off on their motorcycles to run down the dingoes and shoot them with shotguns. Everyone told us that Johnnie the Dogger knew more about the back bush country of Western Australia than any man alive. He had a collection of about 100 tektites which he had either found himself or acquired from the aborigines. He

also had three small meteorites, one a pallasite of beautiful structure (a mixture of stone and iron, the stony material being in the form of olivine crystals). Dr. Nininger arranged to buy his collection and offered to buy any other meteorites that he might find. Carlisle said that about three years before he had found in the desert some 500 miles to the northeast a large meteorite which weighed well over 100 pounds. He had hauled it to the nearest station and notified the museum at Perth, but it was still there when he had last seen it something over a year later. He supposed it was ~~still~~^{yet} there, but we learned later that the museum had finally gone after it. Such lack of interest was hard for Dr. Nininger to understand.

February 16, 1959:

Dr. Nininger had made arrangements for the banker, Mr. Haigh, to take us some 20 miles out in the country to see a man who was said to have "buckets full of tektites". Mr. Haigh and his wife and daughter called for us at the hotel, and on the way out to the station we learned that Mr. Jones, the owner of the sheep station, was a man of outstanding character and ability. His sheep station contained 640,000 acres, or 1,015 square miles of land with the homestead located near the center. On the way out we passed through an old ghost town called Kuanalling which Mr. Haigh told us had once been quite an important gold producer until the much higher grade ore at Kalgoorlie drew the miners away. This ghost town was on Mr. Jones's station, only two or three miles from his home, and I began to wonder what such land might be worth per acre. Later I asked Mr. Jones what such land as his might be worth--what it would sell for--and he replied, "We don't sell gold-bearing land in Australia". This was not an unreasonable answer when one considers that they have taken out over a billion pounds worth of gold from under the "golden mile" at Kalgoorlie. Most of Mr. Jones's 1,015 square miles is flat or gently rolling land and so completely covered with a blanket

of laterite that out-croppings of the greenstone are rare and difficult to find. The chances are very good, however, that under this station, the edge of which is only about five miles from Kalgoorlie, there is another billion or so in gold. The question is, how to find it and whether the ore would be rich enough to pay to mine.

The cost of mining at Kalgoorlie has been increasing with the depth of the mines and the increase in wages until the margin of profit is very low and only the most efficient operations can survive. In my opinion, Western Australia probably has a greater gold-producing potential than any other like area in the world. As Mr. Campbell said, every gold mine in Western Australia is located on or by a mountain (actually only little hills from a few feet to a couple of hundred feet above the surrounding plains) and the structure beneath the rest of the land is unknown. At least 95 per cent, and perhaps 98 per cent of the land area is covered by sand, salt flat, or laterite which hides from view any greenstone or other rock formation. Perhaps the best way to prospect this country would be to get the largest ditch-digger available and start across country to see what is below the laterite.

Mr. Jones and family entertained us on the veranda of their country home which was quite unpretentious but certainly comfortable. Like most big American farms or ranches the barns and other outbuildings were larger and better made than the house, but this is a sign of a sound operation and a self-made man and wife who have had to struggle hard for what they have gained. Jones was a real "out-going" personality with a big smile and a hearty laugh and not at all reluctant to talk about his station, his family, and his interest in collecting tektites. He said that they had about 6,000 sheep and about 400 head of cattle, but that they were cutting down on the cattle and increasing the sheep because it was really a much better country for sheep than for

cattle. Their water problem, he said, was a serious one but they were overcoming it by building stock water ponds and small dams to collect the rainwater.

Soon after we arrived the two oldest boys, about 18 and 20, excused themselves to start on a week's trip to build fence. It seemed that only 400,000 acres were under fence and they were busy just then extending their fences. A few minutes later they drove out of the yard with two big trucks, one carrying a wheel tractor and supplies and the other loaded with aborigines and their wives, children, and dogs. The tractor had an auger attachment to dig holes for the posts and also a power drill to bore holes through the posts. Everywhere in Australia they drill holes through the posts and string the unbarbed wire through the holes rather than staple the wire to the posts as we do in the United States. With five wires on a fence, this is a tremendous job.

As in New Zealand, relatively few sheep are sold for meat in Australia simply because there are so many sheep compared to the consumer demand for meat. Wool is therefore the main cash crop. The wethers (castrated rams) are kept for shearing and in the average year will produce a fleece weighing about 12 pounds.

Mr. Jones was also a collector of gold samples and some of the specimens he showed us were indeed beautiful. He said the actual total gold content was worth around (500). He then brought out his tektite collection, which consisted of some 1,100 specimens. This was by far the finest collection we had seen in Australia outside of the museums. It represented some 40 years of collecting and was important scientifically because it was complete, no specimens having ever been extracted from what had been found by the Jones family in that area.

We returned to Kalgoorlie with the Haighs and were invited to their home for a Sunday-night snack which turned out to be quite a

meal. Mr. Haigh showed us his collection of native weapons and told us several amusing tales about the local aborigines who hang around the edges of the town and beg for food and whatever else they can get. He said that if you once give them something at your door they never stop coming back for more. For this reason the citizens never give anything directly but turn it over to the government welfare agency for distribution. As an exception to this rule he said they had once had several bushels of apples from their trees which they wanted to give to some native families camping nearby. In order to keep the natives from bothering them at the house, Mr. Haigh took the apples out at night and scattered them near the camp. Next morning there was a great hullabaloo and a near riot when the women found the apples and got into a fight over the division of this manna from heaven. The Haighs watched the fracas from their kitchen window and when the fight was over they saw that the natives had begun to wonder where this wonderful fruit¹ had come from. They looked all around, in all directions, and finally they looked up at the sky. The final verdict it seemed was that the apples had fallen from the sky. What more natural conclusion in a desert land where no fruit of any kind is known but where things do fall from the sky.

February 17, 1959:

On Mr. Campbell's invitation I spent this morning visiting one of the mines, under the guidance of Mr. Compton, Jr., the young geologist I had talked with on Saturday. We changed into coveralls, slickers and boots, and miners' hats and took the elevator down into the mine. The elevator consisted of a platform just big enough for four men crowded close together and enclosed by a hand rail about waist level. We got off at the 900-foot level, the 1,100 and 1,300 foot levels, and walked through tunnels (drifts), having to bend nearly double in many places. The main drifts, where the rails carried the ore cars, were shored-up with timbers, but the smaller working shafts were not, being just wide

enough to get a little ore car through. There was water running everywhere and a constant rain dripping from the roof so that our slickers and rubberboots were a necessity. Geologist Compton explained the structure and the theory of how the gold was deposited, and dug out many samples of the ore with his hand pick which he gave to me to take home. He assured me that the company wouldn't mind as the total gold content could not be more than a shilling or two.

I was impressed by the violent folding and shattering of this deep underground structure. It looks as if a giant blast of explosive had shattered the greenstone into millions of pieces about the size of one's fist, and then the whole mass shaken down and compressed until all the voids were filled. Seldom is there a fault plane surface of any size or length.

Compton took me into a large underground room a little way from the lift at the 900-foot level. Here the roof had caved in forming a long room about 80 feet long by perhaps 50 feet wide and 30 feet high. Along one side they had worked out a vein that paralleled the floor and extended into another adjoining room. This left a pillar hanging from the roof but unsupported at the bottom. The rooms had flat fault surfaces along the roof and I wondered how the company bosses had ever persuaded the miners to work out the vein underneath that central pillar. I was very glad to get out of the place, what with those big trucks running around only 900 feet above.

Shortly before noon, Dr. Nininger and I were picked up at our hotel by a Rotarian who was head of the geology department at the School of Mines and taken to the regular meeting of the Kalgoorlie Rotary Club. After lunch we each gave a 10-minute talk which was tape-recorded and later broadcast over the local station. Dr. Nininger talked about his search for meteorite^s and tektites, and I told them about my interest in collision geology and my search for anomalous

conditions in Australia which might point toward cosmic collision as the origin of such conditions.

Mr. Jones was a guest at this Rotary meeting and had come to close the deal with Dr. Nininger for purchase of his tektite collection. He agreed to sell his entire collection except one very large tektite which his father had found and which he especially prized for that reason. It was oval-shaped, nearly two inches long, over an inch wide and about three-quarters of an inch thick, with a flow rim around its greatest circumference. Mr. Jones had not brought the tektites with him so he took us back out to the station in his pickup truck. He carried a rifle slung in the roof of his truck where he could get it quickly. He said they were having a great deal of trouble with wild dogs, city dogs, and two-legged dogs. The latter, gold miners who, though better paid than most Australian laborers, continued to steal sheep.

Before heading east across the Nullarbor, we planned to make a trip south to the town of Esperance on the coast, a distance of 118 miles. When Dr. Nininger and I returned to the hotel from Jones's station about 5:00 p.m., we found Mrs. Nininger ready to start on this next leg of our travels. She had had the camp chair, her seat in the back of the combi, re-upholstered in a local furniture store, the old canvas ~~seat~~^{seat} and back having split out with much travel over rough roads. When we were all ready to depart, she got into the back of the combi and sat down. There was a great ripping sound and Mrs. Nininger went through the new canvas seat. It was funny to the two men on the front seat, but not so funny to Mrs. Nininger. She was ready to chew that furniture man up in small bites and spit him out! The shop was just around the corner from the hotel so the Niningers took the chair to the store and got their money back. We bridged over the canvas seat with some thin box lumber and I promised to buy some clothesline and weave a seat of it the next day at noon.

We got out of town about six o'clock and made nearly 20 miles before sundown, camping off the road a few hundred yards in a nice forest of eucalyptus. It is possible to leave the road almost anywhere as the road gutters are seldom more than a foot deep and the trees take so much of the moisture that most of the ground between the trees is barren of brush.

After supper I got out my Questar and mounted it on the trunk of a fallen tree which made a good solid mount of just the right height. The seeing was by far the best I have ever experienced, the highest magnification being exceedingly clear and steady. The moon was a little past the first quarter so that Mare Imbrium was in a good position to view. We could see the straight wall very plainly and in fine detail. The mountain walls of the Appennines and Alps were very sharp, many small craters being visible which I did not remember seeing in any photograph. The mountain peaks on the rim of the big crater Plato cast sharp, clear shadows on the floor of the crater.

The seeing was very good for several nights thereafter but the moon too bright to see much detail. The seeing in this section of Western Australia should be especially good because it is a forest-covered country all the way to the southern ocean and with prevailing winds from that direction the air must be unusually free from dust. The forest cover should help too in preventing so much heat radiation from the earth. For the next week we experienced quite cool weather even though it was mid-summer down under. The nights were so cold we were quite uncomfortable and the dew so heavy it was almost like rain, getting our bedding so wet we had to dry it out in the morning sun before breaking camp.

February 18, 1959:

We were awakened early by roosters crowing and dogs barking so had not been camped so far away from civilization as we had thought

We arrived in Norseman about 10:00 a.m. where we stopped long enough to stock up on groceries and buy some rope to fix Mrs. Nininger's chair. Norseman is a rather interesting little town of about 500 people but business-wise is bigger because it lies at the crossroads, or ^{the} of the most easterly north and south highway in Western Australia and at the western end of the only transcontinental road in Australia. It is built in a forest of salmon gums at the foot of a good-sized mountain which appears to be some 500 or 600 feet higher. Here supplies are taken on for the trip across the Nullarbor Plain, a trip of over 1,000 miles to the next town big enough to call a town.

Norseman is one of those gold-mining towns at the foot of a mountain like most of the others. The gold, however, is found in what are known as "deep leads" to the mining engineers of Australia. These deep leads are deep clefts or depressions in the granite basement rocks which have been filled to the surface with angular gravels, muds, and some water-worn pebbles. The free gold is found mixed in this mass of detritus. The geological survey maps of Western Australia give the elevation of Norseman as 927 feet but the National Geographic map of Australia shows an elevation of 1,595 feet. Probably this latter figure is the height of the peak east of the town. In any event, the whole country is relatively level and from a prospector's standpoint the deep leads are about as difficult to find as the laterite-covered greenstone dykes. Quoting from Bulletin No. 95 Geological Survey of Western Australia, Pages 207-208:

"The undissected and arid nature of the plateau with its cover of laterite, travertine, clays and sands has had an important effect on gold mining, in that many of the lodes are quite hidden, and have been discovered only by the merest chance; in that few lodes can be worked from tunnels or adits, as may often advantageously be done in more dissected countries; and in that the absence of streams has caused much difficulty in obtaining the necessary water for mining purposes. Against these serious disadvantages, is the great advantage of easy transportation by road and rail. It may also be pointed out that over considerable areas there is not much accumulation

of surface detritus; consequently the bed rock and its contained lodes in those areas are quite close to the surface, although unfortunately a thin cover of laterite or other superficial deposits often conceal the lodes. This cover, however, is a small difficulty compared with that which would arise if great thickness of detritus existed to any extent. That such thick deposits do occur is shown by the records of the deep lead workings".

I offer this quote because it bears out my own observation about the general thinness of the laterite covering and at the same time the very complete covering of the rock structure beneath. This Bulletin No. 95 also bears out my observation of the flatness of this "plateau country," as they call it. For distances from 100 to 175 miles in any direction from Kalgoorlie the maximum fall per mile is $4\frac{1}{2}$ feet and in some instances only $2\frac{1}{2}$ feet per mile. As an example, between Mt. Magnet and Sandstone, a distance of 93 miles, the rise is only 355 feet or an average of $3\frac{3}{4}$ feet per mile. It should be remembered, however, that over most of this country the swell and swale topography prevails, and rises and falls of 100 feet or more in a few miles are the rule. It is the top of this swell and swale topography which remains so nearly level over long distances. To me the word plateau is a misnomer. In other parts of the world the word is applied to mesas or tablelands which are generally above the surrounding country and dissected by streams. Also, in every case I can think of, such plateaus are composed of sedimentary rocks or lava flows.

We left Norseman about noon, well stocked with fresh fruit for lunch which we stopped to eat a few miles out of town. After lunch I made good my promise and laced up a good, strong rope seat in Mrs. Nininger's aluminum camp chair.

For the first 20 or 30 miles south out of Norseman the road passed through tall, thick eucalyptus forest in an uphill-downdale topography, the road fairly straight and bearing south. This gradually flattened out to a more open country with farms and the

timber more scattered and lower. This trend continued with the trees getting smaller and scrubbier as we approached the south coast and finally, for the last 20 miles, nothing but a thick heavy brush growing on sand dunes. Suddenly this long straight road comes to the brink of the great plateau and far below, actually about 1,000 feet, is the coastline with lagoons, sand dunes, and the little town of Esperance in the distance. To the right and left are rocky peaks and many off-shore islands, all of which are lower than the plateau. This comes as quite a shock! After traveling for hundreds of miles across a nearly level country we had got the impression that we were near sea level, and that nothing, and certainly not a mountain, could possibly be below the surrounding country.

The granite promontories rising from the shoreline to the east and west of Esperance are nearly as high as the top of the plateau, but most of the coastline is made up of low granite hills which have been rounded off and polished by the recent Pleistocene glaciation until they are no more than 150 to 200 feet above the sea. Offshore are dozens of islands protruding through the intensely blue waters of the southern ocean, and all are so beautifully glaciated that hardly a cliff or angular prominence appears anywhere on the skyline. There is some vegetation growing on these islands but at least half of the surfaces appear to be bare granite.

We arrived in Esperance about 4:30 in the afternoon and failing to see a good place to camp, decided to stay in the hotel. Esperance is an old beach resort but so far from the haunts of men that it never has attracted any number of people. There were two small resort hotels on the beach and a number of cottages for rent but not a soul in sight on the beach. Next day we did find a trailer camp up the beach about a mile but there were very few trailers there. There are probably 500 or 600 people in the whole town, but some day this may well be a famous beach resort, for a more

beautiful place would be hard to ^{imagine} describe. It has ~~x~~ beautifully protected coves with fine sand beaches and smooth granite points extending down into the water; fine waves for surf-board riders, and many little islands offshore for boaters to explore.

On the main street of Esperance, near the post office, is a row of Norfolk Island pines or star pines as they are sometimes called. These trees were well over 100 feet tall and about five feet thick at the base, with thick, deep green foliage, yet they grow on land not more than 10 feet above sea level nor more than 100 yards from the ocean.

February 19, 1959:

Not far from Esperance we came upon the largest granite dome we had yet seen. It was oval shaped and rose quite abruptly about 400 feet above the surrounding mesa. At many places it was too steep to climb, its sides being well rounded and smoothed by glaciation. I climbed about half-way up the side of the dome and could see no sign of real glacial polish, the surface ^{having} being long since succumbed to decomposition and to exfoliation. There was, however, considerable evidence of ice gouging and grooving along the base of the dome. About half-way up the dome and on a more gently sloping area were a number of perched boulders. I could also see some big ones on the top of the dome. This would seem to indicate that the ice melted in place and left the boulders stranded and they have since been rounded and perched by the usual weathering and exfoliation. This area must have been covered by a thick ice cap that was not moved by oceanic flooding.

There were a few potholes and cracks in the rock where vegetation had made a start and among other plants was a wild geranium in bloom. Around the foot of the rock and on the surrounding mesa was a cover of thick brush about six to eight feet high interspersed with a kind

of palm with a thick head about four to five feet in diameter and a stem a foot thick and eight to ten feet tall. The brush had been burned to clear the land for farming but the thick succulent stems of the palms resisted the fire so that they had to be knocked down with a tractor and were heaped in piles for later burning.

It was in this area that we saw some of the paper-bark trees which grow among the sand dunes and along the edges of the salt sloughs that lie south and east of Esperance. They only grow to a height of about 15 feet and tend to branch from the ground extending upward in a clump. We were told that they made excellent fence posts because the high salt content of the wood prevented fungi and termites from attacking them. The bark is about three-quarters of an inch thick and composed of dozens of thin layers, no thicker than paper, which can be separated or peeled off the tree.

We had been unable to find anyone in or around Esperance who had any tektites for sale, so we decided to return at once to Norseman.

On the way down from Norseman and back, and later along the Nullarbor road, I had an opportunity to see at close hand some of the numerous dry lakes I had seen earlier from the air on my flight from Adelaide to Perth. There are not many lakes immediately south of Norseman, but as soon as the open country begins there are dry lakes on either side of the road all the way to the edge of the plateau where it breaks down steeply to the sea. In a distance of 80 miles there is no stream drainage whatever, and the fall, if any, is certainly not more than ^{2 or 3} ~~24~~ feet per mile. The lakes are seldom more than a mile across and the average ^{lake} appears to be fairly round or oval in shape; all, whether large or small, are about the same depth--20 to 30 feet.

A typical lake a quarter of a mile in diameter from rim to rim will be about ^{perhaps} 900 feet across the bottom with a ring of willows around the shore line. The lake itself gives no indication of ever having

held more than two or three feet of water in the wet season and the sloping sides of the lasin have, in most cases, been cleared and planted to wheat or other small grain crops. The farming operations have rounded the rims to some degree but even where the original forest cover remains the edge of the rims is not very sharp. The road cuts across many of these lakes and affords good cross-sections of the rims which in most cases are ^{a fine cream-colored sand} beach sand four to six feet deep covering a yellow limey shale.

Farther north around Norseman and east along the Nullarbor road we saw a good many lakes in the thick eucalyptus forest country. Most of these had a fairly steep rocky slope on the west and north-western side rising from 10 to 30 feet above the dry lake bottom and sloping away to a low sand rim on the east and southeast side. Like the other lakes farther south they gave no indication of older, higher shorelines but presented evidence of having held only a foot or two of water in the wettest season.

^{edge of the} On the plateau a little way north of Esperance I saw a number of dry lakes which were relatively shallow basins and which appeared to have drainage one to another. Unlike any others these had a central plateau which was three or four feet higher than a channel around the rim of the lake. In one of these the channel contained water with reeds and other plant growth, indicating that the water was present most of the year although the central portion of the lake, the plateau area, was dry, ^{leaving a sort of ring lake} We were told that the rainfall along this coastal area was from 15 to 18 inches per year. Probably the thick blanket of fine sand above the clay and granite tends to keep the water table relatively high.

Imagine a stretch of country 1500 miles wide and as much as 500 miles north and south covered with these more or less symmetrically shaped lakes, and never a stream of any kind to fill them. In most

parts of the world we expect to see small streams or dry creek beds entering a lake even though it may be dry most of the year, but these dry lakes are without visible stream support. Usually they are found in groups with adjacent terrain, looking exactly the same, being devoid of lakes. The whole land is so nearly level that the depressions are only a little lower than the gentle rises between and the lakes are found anywhere and everywhere--on slopes, on rises, or in depressions.

Many Australian geologists have remarked on the peculiar features of these lakes. Bulletin No. 95 of the Geological Survey of Western Australia devotes a whole chapter (Chapter X, pages 213 to 228) to "The Salt Lake Division of Salinland." Herein, a number of geologists are quoted as to the origin of these lakes, but most of the discussion is confined to the larger irregular and elongated lakes which are closely associated with the deep leads by the mining industry. As indicated earlier, these deep leads are deep ^{in the granite} troughs, ~~like those along mountains in the deep ocean.~~ ^{and} They are not true canyons but are rather fault troughs in the basement rocks. In Western Australia many of these troughs have been filled with a detritus of gravels, angular fragments of rocks, sand, and clay. ^{of the deep leads} Some in the higher country around Kalgoorlie and Norseman have been mined for free gold which seems to ^{been} have been carried into these depressions by water action. Some of them have been so completely filled that there is no indication on the surface of their existence; only excavation shows where the hard rock walls may be.

The large, elongated dry salt lakes which I saw near Kalgoorlie and Norseman are apparently of this nature. Lake Cowan just north of Norseman is about 50 miles long, and Lake Lefroy, a little farther north, is some 30 miles long. Both of these lakes have steep rocky shorelines on the western sides which descend into the lake bed at a

steep angle. The generally flat country breaks off in steep walls from 50 to 75 feet high and the whole thing gives the impression of a deep trough in a flat landscape filled to within 50 feet of the brim. *It was when they were out of it in some of these lakes* They mine salt in some of these lakes by scraping it up in long windrows with road graders after the rains crystallize the surface layer into clean crystal salt.

The great number of smaller lakes of oval or circular nature *have not been* ^{mentioned} are not considered by the geologists beyond the mention that most of them have steep rocky shores on the west side and flat sloping sandy beaches on the east side. They have failed to see anything unnatural in thousands of little oval lakes lying on nearly flat land, as many of them on the tops of the rises or slopes as on the lower elevations, and without drainage pattern to have formed them.

The author of Bulletin 95, J. T. Jutson, is of the opinion that all of these lakes were formed by a combination of deformation and wind erosion. I maintain that it is impossible to account for such lake depression by wind erosion or any other ordinary form of erosion. Wind erosion is not known to produce depressions in flat country in any of the deserts of the world. The only place in the world where wind is known to dig holes of any size is the Seistan Depression of Persia. Here in a vast depression surrounded by high snow mountains there occurs at one season of the year what are called "the 120-day winds" which blow down off the high mountains at velocities sometimes over 100 miles per hour. This condition is caused, according to meteorologists, by cold heavy air flowing downgrade from high altitudes and replacing warm air which is rising. It does not occur in flat country like Australia but only where mountain canyons or passes tend to funnel this cold heavy air into a stream. Southern California has a similar condition in winds that occasionally blow down the Santa Ana Canyon into the Los Angeles

Basin in the fall of the year. These are known locally as Santa Ana winds, but their velocity seldom exceed^s/40 miles per hour and they have never been known to produce ablation basins.

Jutson further advocates the theory that all of these lakes, large and small, are migrating toward the west into the prevailing west winds. The rock floor and rock walls on the west side, he feels, are due to wind ablation. After rains, when a few inches of water accumulates, the beach lines on the east side, he thinks, follow the migration westward. According to him the rising salt kills the vegetation as the lake moves across the land.

I saw no evidence of such migration. ~~Most~~^{Many} of these lakes are surrounded^d by trees and shrubs, the larger and stronger vegetation being on the western rim. I judged that the salt blows out on the east side confining the vegetation there to small shrubs and annual plants that are highly salt resistant. However, there is no strong evidence that this is occurring now to any extent. In fact the rims of most of these lakes which I saw from the ground were so thickly wooded with trees 20 to 30 feet tall that even very strong winds could have little effect. There is no evidence of strong prevailing winds in the growth of the trees.

In the area south of Norseman toward Esperance I saw many lakes' which were merely depressions in a gentle rolling plain covered with a blanket of ~~laterite~~^{sand}. There is no steep bluff on any side of these basins and not much sign of salt. Most of them are in a grain-farming country and nearly all are surrounded^d by willow or other trees. Certainly, no migration here.

In my opinion there is no real evidence that any of these lakes are migrating now or that they ever did in the past, either by wind ablation or other means of erosion. Sand dunes may move across country, and the movement can be seen and it can be measured from month to

month or even day by day. But where is there a desert country with dry lakes moving across the landscape, all of them roughly the same depth but of greatly varying diameters? How is it that around Norseman most of the lakes in the forest country have a steep rocky shore on the northwest side and a low flat shore on the opposite side, with a few exceptions in which one side is as high as the other? How do we explain the fact that these dry lakes gradually change in form as we move south toward Esperance? Within a dozen miles they change to a form in which there is no low side, only a flat sandy plain with basin-like depressions of all sizes scattered over the landscape. How do we explain the fact that these basins gradually grow shallower as we move south until some are only about six feet deep and with a plateau perhaps three feet high in the center with a channel around it?

It is my belief that these lakes are the result of a combination of forces following the last major collision and oceanic flood. Australia, being ^{on the} ~~almost~~ ^{side of} opposite ~~on~~ the globe from Bermuda, ^{the place} where the last collision is believed to have occurred, ~~it~~ ^{it} was less violently affected by oceanic flood; but, ^{its location} ~~being right~~ on the edge of the old Antarctic Circle, ^{meant} there was plenty of flat-bottomed sea ice to be washed inland ^{and} ~~to be~~ stranded on the flat tableland of Western Australia. The trough depressions were filled with angular rock, gravel, leaves, sand, and other debris, including gold, ^{by the oceanic flood.} Some of the bergs came to a stop in rock debris or the decomposed granite blanket which must have covered most of the land, plowing up an embankment of loose rock and other material on the west ^{or} side, that being the direction they were traveling. The other side was left low and flat. But sometimes, depending on the topography and various other conditions, sand rims were produced all around the stranded bergs, or perhaps none at all. In the case of chains of lakes, it is likely that a large

elongated cake of ice broke up into several smaller pieces upon running aground and thereafter the receding waters carried sand and gravel in between and around these bergs until they were quite separated from one another. When the bergs melted and the water evaporated, a chain of dry lakes had been produced with no stream connection from one to the other.

The continent of Australia was a polar desert before this catastrophe and remained a desert afterward, except along the coast. The flat cakes of ice preserved the land beneath from erosion and also from sedimentation, and the widest and most distinct shorelines were on the sunny side ^{East + North east} where the ice melted fastest. Ice cakes could have occurred in fleets, accounting for the fact that in some of the very flat areas near the sea coast numerous lakes occur, while nearby on exactly similar ground there are none. In other localities they grounded at random and it can be expected that some might ground on slopes or the tops of low ridges or in valleys, the whole land being so nearly level, ~~that~~ there was not much tendency to slide

downgrade into the depressions. Thus lakes were produced in the most unlikely places and no entering streams were needed. ^{Since this catastrophe occurred in the middle of the S. Hemisphere it}

The reader should recall the fact that the whole of Western Australia ^{is now} is underlain with strong salt water, chemically like the ocean, and ^{this area into a warm zone since} this in a land where the hard basement granitic rocks come right to the surface being scarcely anywhere covered by more than 20 or 25 ^{feet ice} feet of decomposed rock. In the United States decomposed granite ^{melted slowly and much of it by evaporation in this desert.} soil is almost a sure indicator of high-quality water. How then did ^{so that stream channels did not develop.} similar rocks in Australia get so thoroughly impregnated with salt water if not by ocean flood, and ^{by having} been deep sea floor in still earlier time.

The reader will no doubt consider the above not a theory but mere speculation--conjecture without experiment, according to dictionary

Development in Australia

definition. In answer I must admit that I have not performed the actual experiment but I am confident that a scale model of the Australian plateau could be built and ice cakes floated in and stranded on it in the way I have described, and that the same results would follow.

On the other hand, I have observed these phenomena in stream flow and especially in tidal basin flow: 1) A stranded object which produced a bluff or rim on one side and a very low rim or none at all on the other side. This corresponds to the type of dry lake which Jutson calls migratory--a rocky rim on one side and none at all or a very low rim on the other, which he proposes were made by wind erosion. 2) A stranded object which had a sandrim entirely around it and half bur^ying it. This happens in a very slow current, in a wide tidal mud flat or shallow stream. 3) I have seen a stranded object produce a pedestal, the receding water washing a channel around the object below the base of the object and yet leaving the surrounding sand flat higher than the base. (Jutson fails to mention the second and third types of lake depressions and I have been unable to find any other reference to them.)

In each of the above cases, the object which produced the surrounding erosion had to be removed before the basin was in evidence. Ice, we insist, is the only thing in nature which could have produced the three types of depressions and then have vanished--melted.

If we try to imagine how wind erosion could have made these three distinct types of lake depression in the same relatively small area, the absurdity of the idea becomes more apparent. First, all three types are of the same age and of very recent origin. They are all in a forest-covered area and there is no orthodox geological reason to suppose that the forest were not there when the lakes were made. But even if we remove the possibility of forests and how they might

have prevented wind erosion and imagine instead the whole land surface as barren and covered with sand, then it is still impossible to expect wind to perform such antics. In fact it would be very difficult to build a scale model and produce the three kinds of depressions even with a vacuum suction tube. It would require a separate and special nozzle for each type of crater depression.

Jutson's migratory theory would also be very difficult to simulate in the laboratory except by special equipment which would in no way resemble winds blowing across a nearly level landscape. The idea that lakes may slowly migrate by a process which leaves a continuous steep slope on the windward side and a flat open side on the other is like imagining a gold dredger that could chew up the rock in its pathway and blow it out as a dust so fine that it would spread far and wide as a thin blanket over the landscape, and all this so slow that the dredge would only move a few inches a year.

Orthodox geology has long called upon the genie of inertia, of extreme slowness, to answer whatever problems could not be answered in a logical manner. Imagine a climate where winds are now so gentle that a carpet of leaves covers the forest floor right down to the edge of many of these dry lakes, and then try to explain these lakes as the product of wind erosion, a wind erosion that supposedly caused these dry lake beds to actually migrate a few thousandths of an inch each year. This type of reasoning is one with the discussions of the Middle Ages as to how many angels could stand on the point of a needle.

I feel that the orthodox geologist should follow his own rules, and his supreme rule is the so-called Law of Uniformity: That we can only project present processes of change, sedimentation, and erosion into the past to explain the origin of prehistoric features on the earth. I insist that the orthodox geologist show me, the catastrophist, where wind erosion, for example, is producing the effects today,



CHAPTER XA C R O S S T H E N U L L A R B O R

. We arrived in Norseman about 4:00 p.m. and after stocking up on groceries, fuel, and water we started east on the Nullarbor road. We drove 86 miles that evening before dark, passing only one car, going west. We heard another car pass in the night. Our thin cotton blankets were not enough to keep us warm and Dr. Nininger was up by 3:00 a.m. keeping warm by the fire. We had made our camp near a cattle ramp (cattle guard), and it had been a big mistake. Under the ramp was a pond of water which was the home of a million mosquitos. A heavy dew, which made it necessary to dry out our bedding in the morning sun, contributed to a less-than-desirable night out.

Australian cattle ramps are made by narrowing the road down to the width of a car, digging a hole about six by eight feet, boxing it in, and placing rails across for cars to pass over. The gutters on either side of the road carry what little rain falls down the road and into these boxes beneath the ramps. The ramps are seldom closer than eight or ten miles apart, being located where division fences between stations happen to cross the road. No fences have been built paralleling the Nullarbor road, the livestock being so few in number relative to the acres, the cars so scarce, and the road being so straight that there is little danger of an animal being hit. We found that the local citizens give directions by telling you how many cattle ramps to cross before reaching a turnoff.

February 20, 1959:

We arrived at Belladonia Station about 10:00 a.m., filled our tanks with gas and water and inquired about the Crockers who were supposed to have tektites. -191-

The building which was both gas station and store was situated about 200 yards off the main highway, a condition which seems strange to the American traveler but which is a rule along the Nullarbor road. It was built of odds and ends, with a tin roof and had the usual herd of 50-gallon petrol barrels standing in the yard. Behind the store was an outcrop of granite and a small lake furnishing the water supply. Still farther to the rear we could see a larger granite dome and we were told that behind it lay the Belladonia Station, home of the Crockers.

We followed a little dirt road which led around the granite dome about a quarter of a mile and there came upon another lake and by it a rock house with trees and garden around it. It seemed truly like an oasis in the desert. The usual sheep dogs came out to greet us followed by Mr. Crocker. He had been helping his son on a wheel tractor in the near-by field, the last plowed field we were to see for more than 800 miles. Mrs. Crocker joined us, coming from a near-by shed where she had been milking the cow.

Dr. Nininger told the Crockers of his search for tektites. They said that their collection was long gone but that some neighbors to the east had some and Mrs. Crocker called them on the party line to make sure. She then invited us in for a cup of tea and when I admired some of her oil paintings she showed us her collection of Australian insects, done in oil. The butterflies, beetles, spiders, and others were so perfectly done that they seemed alive on the canvas. The finest detail of line and color and every shadow cast by leg or wing was there to make the creature stand a living thing. Mrs. Crocker had also painted some fish and horses which were almost photographic in their perfection. After thanking the Crockers for their help we departed for the neighbors owning the tektites who lived some 16 miles to the east of the Crocker station. After wandering through open bush

country over a little-used road which was not much more than a trail, we arrived at their home built alongside the ever-present granite watershed. This granite outcrop, however, was unlike any other we had seen. It was a smooth granite slope of about five acres which began at the top of a ridge and sloped down to the north. A small depression had been dammed off forming a pond of about a half-acre and the house was built alongside the pond. The Niningers purchased seven tektites from this family, and we started back to Belladonia Station.

On the way, I decided to stop and ask Mrs. Crocker for the privilege of taking some color photographs of her remarkable paintings. She very graciously agreed, and while I took the pictures we learned some of her history and that of the Belladonia Station. Her parents had pioneered here, hauling all their supplies in from the coast 70 miles to the south by camel wagon train, and in like manner shipping their wool crop out. Each large wagon was pulled by 12 camels hitched in teams of two to a log chain. Mrs. Crocker said that camels had been in use in that part of Australia up until the Americans built the Nullarbor road during World War II. Their large stone house had been built in 1926. Mrs. Crocker, like the children of most other pioneers, spent most of her early years attending school in the city and was well educated. She was an extremely charming person.

We got away from Belladonia about 1:30 p.m. and continued eastward through a more open grass country. About mid-afternoon we stopped to look for tektites and to stretch our legs a bit, when I happened to notice a snake lying in the middle of the road about 50 yards ahead. We decided at once to get a picture and Dr. Nininger

hurried down the road to hold the snake's attention while I got my camera ready. As I came up he warned me that it was a mulga snake which we knew to be one of the world's most poisonous snakes. Its bite is deadly, there being no known antidote. With this in mind, I stopped about 15 feet from the snake and took a picture but neither of us had any idea that such a snake might attack a man. We were both accustomed to the slow movements of our American rattlesnakes and quite unprepared for what happened.

It was not a very fearsome looking snake, only about four feet long and a little more than an inch in thickness with fine pointed tail and a small head. In color it was a very dark brown, almost black. It made no move but lay stretched out in the middle of the road while I moved a little closer for another shot. Then to get a little more action, Dr. Nininger tossed a small stick on the snake. Instantly it raised its head, turned, and made for its tormenter. He turned too, racing across the road and into the grass with the snake right at his heels. Here he made a quick left turn and the mulga continued on into the thick grass.

Needless to say I decided against taking any more close-ups of this snake in the grass. We climbed back into the Combi and resumed our journey, the good doctor a little "shook" and somewhat short of breath.

As we traveled eastward the trees had gradually thinned out and grew smaller, and the eucalyptus had given way to the more hardy mulga, but there was still plenty of firewood to be had and we certainly needed it that night. It was so cold by sundown that the Niningers decided to sleep inside the Combi and accordingly removed most of the baggage and spread their pads on the floor. It was warmer inside, they reported in the morning, but the corrugations on

the floor came through the thin pads and they decided that the cold was to be preferred thereafter. I had lined the Combi up at right angles to the night wind and managed to sleep quite comfortably against the lee side by building a long fire just in front of my cot and almost under it. On a cold night a bed of coals under a canvas cot allows you to put the pad and the rest of bedding on top. We had thought that summer weather in the desert of Western Australia would be uncomofortably hot and that a pad beneath us and sheets and a thin cotten blanket would be plenty. We were quite wrong, as it turned out, but we managed to survive the discomfort of a few cold nights.

February 21, 1959:

We broke camp early (7:30 a.m.) and put in the longest day of any of the whole trip. We covered 314 miles, driving until nine o'clock at night to reach Nullarbor Station.

About noon we came to "The Pass" near Mildura. We had been traveling all morning across a nearly level limestone plain which extends across the southern coast of Australia. This plain is about 350 feet in elevation along its southern edge where it breaks off in a steep escarpment to the southern ocean. From this edge the lands slopes very very gently to the north, but so gradual is the slope that it is impossible to tell by looking to the horizon ahead which way the slope might be; and of course there is no sign of water flow which might indicate the direction.

We had been studying the map, expecting some sort of low mountain which would have to be crossed, but we had not reckoned with the Australian interpretation of the word "pass." We simply came to the edge of the plateau and there a sign read "Mildura Pass" and we looked down a straight slanting paved road to the plain below. Since the escarpment was very steep it was necessary to slant the road along the slope to get a better grade, so the road turned back along the face of the escarpment to the west for about a mile to the Mildura Station

which lies on a rise just at the foot of the bluff. We saw a well near the road and heard the sound of an engine pumping water--the first water we had encountered since leaving Belladonia, a distance of more than 300 miles.

Mildura Station consisted of a rock house used as a private residence, bar, eating house, and hotel, with a small warehouse nearby and the usual yard full of petrol barrels which a petrol truck was filling as we drove up. We had lunch in a private dining room and then resumed our journey toward Eucla, but not before we had a big argument about directions. Dr. Nininger insisted that we had taken the wrong road and were going directly west again, the way we had come, except that we were now at the bottom of the escarpment instead of on top of it. With the aid of the map, Mrs. Nininger finally convinced him that we must be right, although we couldn't convince his sense of direction that we were going east instead of west. It is a queer feeling to be down under and off to one side. The sun gets around on the wrong side of the North American and stays there, and no matter how many times he stops to reason the thing out the "still small voice" of his sense of direction keeps telling him a continuous lie.

The road paralleled the escarpment for perhaps 50 miles. It was an absolutely straight road on a level plain and so near the high paralleling bluff that the two seemed to disappear at the same point on the horizon. This high escarpment follows the coastline closely along the Great Australian Bight until it gets to Eyre where it begins to cut inland on a long curve reaching the coast again at Eucla. This platform of low lying land left along the coast is only about 20 feet above sea level but is 20 miles wide and nearly 300 miles long, the southern edge marked by a string of sand dunes that are another 20 to 50 feet higher and seen as a ragged white line on the southern horizon.

Because the road was so very level, we could see mirages almost
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continuously down the road ahead, so we were not surprised to see our accompanying escarpment disappear in a white cloud in the distance. We were nearing Eucla where the shoreline meets the escarpment again and the white clouds turned out to be sand dunes that mounted up the cliff.

Eucla was known to Dr. Nininger as the home of some very fine tektites because those found in the dunes were said to be better preserved, the thin edges not so often broken off. The town consisted of one house made of railroad ties stood on end, a small shack in the rear, two windmills, and a pen containing two small kangaroos. A real gas pump stood in front of the house and the walkways around the house were made of beer bottles driven in the sand neck down, the thick bottoms of the bottles making a very good walk, compared to walking in the deep sand.

A pretty blonde girl of about 15 years came out to pump the petrol for us and Dr. Nininger learned that her mother had some tektites. After some scurrying around in the dark recesses of the store and home they found about 15 tektites, most of them strung in a silver-mounted necklace and earrings. She also had one perfect button-shaped tektite with a beautiful translucent skirt around the rim. This would have been a really important addition to Dr. Nininger's collection, but the lady couldn't be persuaded to sell it, or any of her other specimens either. We had to be satisfied with taking pictures of the lot lying on a white cloth in the sun.

We reached the foot of the escarpment just beyond the town and here found Eucla Pass--a stretch of paved road extending a quarter of a mile to the top of the bluff. The trees along the face of the escarpment were thick and of good size (15 to 20 feet tall). We reasoned that the high steep bluff at right angles to the prevailing winds produced an up-draft and consequently a cooling effect, giving the immediate area

a higher rainfall, for the trees disappeared a few hundred yards inland from the top of the escarpment.

The road followed along the top of the rim for a few miles and on coming to a sign pointing to a "blow hole," we stopped to examine it. It was a hole about 20 inches in diameter in a slight depression, and if it hadn't been for the sign we would never have seen it. The blast of air coming out of it was fairly strong and quite cold compared to the warm air in the heat of the day.

The remainder of the afternoon was spent in driving across the driest part of the Nullarbor plain. Most of this area is nearly barren of trees--on each 160 acres of land perhaps one old crag of a tree standing 10 to 15 feet high against the strong prevailing wind from the south. Only small sections are absolutely treeless, and nearly all of the area is covered with a low grey brush about a foot high.

We had intended to camp for the night at some government water tanks which were indicated on the map. These tanks are spaced about 50 miles apart and were built to provide precious water along this otherwise waterless desert. To our amazement we found that holes had been broken in the tanks at ground level and only a few inches of slimey green water remained in the bottom. It seemed like the work of vandals, but I have since been told that the government had built the tanks without outlets, so that travelers in need of water for themselves or their stock had no recourse but to break into the tanks, thus rendering them useless to those who followed. Five tanks had been built at each station, each with a capacity of 1,000 gallons. The V-shaped tin roof above the tanks caught the rainwater and also provided a shade for cars to drive under during the day, but a more dismal camp than this I have never seen. The wind was blowing a gale from the south and the dust was flying off the nearby graded road. Empty tin cans and other filth was all about, and there was no protection from

the wind. We decided to go on the 16 miles to Nullarbor Station although it was just then getting dark.

Nullarbor Station is the farthest outlying sheep station from the eastern approach of this desert and the little water they get is from deep wells. Why this water is not salty too is something of a mystery but it may be due to the fact that it is a limestone cavern country and therefore has been well drained and leached of the salt. The station itself is a ramshackle group of building^s made of rocks, railroad ties, and bits of lumber, with some sheep pens in back. It sits back from the highway about a half-mile and is approached by a road fully 50 feet wide with five or six different tracks. You take your pick; they are all rough and all hub-deep in dust.

We arrived about 9 o'clock and pulled up at the gas pump just behind our own cloud of dust. The owner filled our tanks with gas and very kindly invited us to stay the night in one of the cabins he had lately built to accommodate travelers. The rooms were two in number, with cement floor^s, each about 10 feet square, and they were separated by a small room containing a toilet and washbowl. One room was already occupied by two shepherders and the other had been recently used, apparently, to butcher sheep, for a big pool of dried blood covered most of the center of the floor. In one corner was a very dirty bed tick filled with straw,--and that was all.

Across the front of the two rooms was a porch about four feet wide with a wall about three feet high around it to keep the sheep out. Mrs. Nininger somehow got together a little cold food while Dr. Nininger and I got the cots out and made up the beds. The Niningers slept inside and I made my bunk on the porch. Less than ideal, to say the least, but we were thankful even for this place to get out of that howling wind. About 4:00 a.m. a couple of half-starved sheep came on my porch through the swinging door. By this time we were all awake so we made ready for the road.

Dr. Nininger had offered to pay for our lodging the night before but the owner had refused any money saying he had built these accommodations for the public. In the morning we looked about and saw the 20 or 30 sheep, the motherless lambs every sheepman must take care of somehow, and, looking beyond, the gray salt brush extending to infinity in every direction. Not a tree, not a hill, not another thing in sight. What a place to live! This man never gets out of sight of home until he goes over the horizon.

February 21, 1959:

About 12 miles down the road we found a place to cook breakfast-- a big hole some Yank had dug with a bulldozer to idle away the time or to make a place to get out of the wind. The hole^e had a 10-foot backstop of dirt behind it, so we built our fire out of the wind and had ourselves a really good breakfast of pancakes and hot coffee. The wind was still blowing a gale from the south and we could see the top of a ragged cloud bank in that direction and decided it marked the coastline or the edge of the escarpment. The clouds came in over us while we were eating but soon cleared away and the wind went down.

For the next 30 or 40 miles the country was still open but much more grass was in evidence and every few miles we passed through another sheep ramp showing that there were sheep stations on either side of us although we did not always see the buildings. Beautiful grass a foot tall covered most of the land now, with thick groves of fairly large trees over about a third of the area. There were no visible streams and no sign of farming operations except for some wild grass cut for hay. Each station had several windmills and we ^{saw} ~~say~~ many in the pastures, indicating that the water table was not far below. The rainfall must be considerable in this area.

This is a swell and swale limestone country. The limestone overlays

the granite for a distance of over 700 miles across the Nullarbor. At the center, where the surface is so very level, the limestone is over 800 feet thick, according to Australian Geological reports, but as it thins toward the edges it begins to follow the contour of the old granite sea bottom. There are a number of limestone caverns along the Nullarbor escarpment some of which are said to be quite remarkable. The blow holes mentioned earlier are a part of this limestone cavern process, being holes which extend from the caverns below to the surface of the plateau. What makes the cold air rise against warm air above is more than I can understand unless the cave has a large opening somewhere along the face of the escarpment and the pressure of the wind blowing into the mouth of the cave pushes the colder air out through the narrower opening at the top at increased velocity. It may be too that a Venturi shaped opening at the top speeds up the air.

We got gas at a place called Poochera and drove on about 25 miles to where we found a side road leading off to some newly cleared land. The eucalyptus trees, here about 30 feet high and eight inches in diameter, had been pushed over with a bulldozer, ricked up in windrows, and burned. It was plenty cold again and Dr. Nininger was up by 2:00 a.m. to sit by the fire. We all got up at 4:45, had a big breakfast, and pushed off for Adelaide.

February 22, 1959:

At about 10 o'clock we stopped at a town called Kyancutta where Dr. Nininger knew of a man named Bedford who had a museum and, supposedly, many tektites and meteorites. He had corresponded with Bedford in years gone by and had bought meteorites from his collection. As luck would have it, the first man we met was Mr. Bedford, walking along the road toward his house. Where was the museum? Right there, he said, pointing to the first house.

We soon learned that this man was the son of the elder Bedford

who had been the amateur scientist and museum director, now dead some years. We were invited into his home where the family was having a late Sunday morning breakfast, and then went over to his mother's house which was a part of the museum. The elder Mrs. Bedford had recently broken her hip but she was determined to walk again and was hobbling about on a cane.

In talking with Mr. Bedford about meteorite craters we learned that he had a light plane and that he knew of some crater-like depressions on the Eyre Peninsula about 30 miles to the south on Anxious Bay. He offered to fly me over to see them and I took him up on the proposition at once. The end of his landing strip was only about 100 yards from the house, a short clearing he had made in the eucalyptus forest. We pushed the plane out of the hangar, warmed up the motor, and were soon off across the Eyre Peninsula.

Kyancutta is in the western edge of the grain county and about one-third of the land has been cleared and planted. The remainder is covered with a thin scrub eucalyptus forest which grows a little stronger on the sand ridges that corrugate the peninsula from southeast to northwest. ~~(picture)~~ The sand ridges are a light pink color and the soil between is dark red so that when viewed from the air the ridges stand out in contrast to the darker background. The trees take all the moisture so that no underbrush grows and the red soil is bare between the trees. It is a granite country with a few small domes rising above the general level here and there and a rough rocky coastline with many indentations and coves.

We passed over a number of dry salt lakes most of them filling natural depressions in the granite and some smaller circular ones which appeared to be the iceberg variety.

The craters which Mr. Bedford thought might be of impact origin were close together, all in a row with their rims touching. The

biggest was about 200 feet in diameter and perhaps 75 feet deep. They were all too deep for their diameter, to be classed as meteoritic, and the grey color of the surrounding soil made me decide that they were limestone sinks which had been left in a remnant of limestone that had once covered most of the Eyre Peninsula. I took photographs and we returned to Kyancutta.

On landing I found that Dr. Nininger had purchased a 260-pound Henbury meteorite from the Bedford family museum and was needing help to load it in the Combi. It was placed in the center of the floor on some boards to ^{dist. it to} spread out the weight and Mrs. Nininger's camp chair was placed over it. Thereafter the center of gravity was ^{really} plenty low!

The Bedford museum was well worth seeing. It was not large but its meteorite collection was almost as good as those in some of the big city museums. Most of it was crowded into a big room about 20 by 30 feet with a 12-foot ceiling. Specimen cases were packed as closely together as possible on the floor and around the walls, and the walls themselves were covered with native weapons and artifacts from many parts of the world.

The senior Bedford had been an avid collector of almost anything of a true scientific nature and he was a good scientist in that he numbered and classified everything he collected. He had been well educated in England but was not an institutional scientist; he was just a hobbieist who loved to collect. We also learned that he was a "thorn in the side" of some of the big Australian institutional men who failed to compete with his drive and determination to collect things. Soon after the Henbury meteorite craters and the Box Hole meteorite crater were discovered near Alice Springs, he and his son went there in an old Ford truck and hauled home nearly a ton and a half of iron meteorites. Bedford traded these specimens and sold

them to collectors and museums all around the world. It was from Bedford that Dr. Nininger had got his first specimens of Australian meteorites. The family had two big chunks of the Henbury fall left, and Dr. Nininger bought one. It is roughly rounded in shape and about a foot in diameter and is perfect except for two small corners which had been sawed off to get specimens for trading.

Among other things, the Bedford museum contained English armor, plaster casts of stone-age African drawings, facial casts of many wild tribes of the South Pacific and of Africa; collections of weapons from Fiji, Zululand, Borneo, and Malaya. The Australian aborigine collection was outstanding; also many gold specimens, minerals, tektites, and fossils. Among the fossils were some opalized clams from an area south of Alice Springs. These fossils are perfect, about an inch and a quarter wide with the two halves still connected. The surface retains its natural appearance and only by grinding through it is the beautiful irridescence of the opal seen.

From Kyancutta we got into a rougher country and a much drier desert again, especially around Iron Knob. There is quite a sizeable town here by the side of a lone mountain of iron ore. Near here we saw a dry stream which showed signs of having recently carried considerable water. We had been traveling for many miles along a pipeline which paralleled the highway and learned later that it carried water to the little towns on the Eyre Peninsula.

By evening we had reached Port Augusta, which is a city of about 10,000 people at the head of Spencer Gulf. Spencer Gulf is a triangular-shaped body of water that separates Eyre Peninsula from Yorke Peninsula. It is about 220 miles in length and 20 to 50 miles wide.

February 23, 1959:

We left Port Augusta about 7:30 a.m., much too early for any eating place to be open, so drove about 50 miles south along the sound

to Port Pirie where we found a little hotel in which we could get a meal. This was an extremely scenic drive because the Flinders Range parallels the edge of the sound and the road lies along the foot of the mountains. The highest peaks are a little over 3,000 feet and the mountain wall rises steep and rugged with many good-sized canyons cutting across the steeply sloping plain which reaches from the foot of the mountain down to the edge of Spencer Gulf. This plain is about five miles wide, on the average, and contains many well kept farms. Each stream bed (dry when we saw them) has a row of ancient gnarled eucalyptus trees along its banks and all the land between streams is farmed to some crop or in pasture.

We arrived in Adelaide about 1:00 p.m. and found our way to the South Australian Hotel where we had rooms reserved. Our camping experience was over; we had traveled by car 1500 miles across the Australian desert in mid-summer, and apart from cold nights and a few minor discomforts, we hadn't found it the difficult feat our Australian hosts had made it out to be.

The pilot, Captain Swan, had heard from the stewardess that we were geologists looking for meteorite craters and other geological features so he invited us up to the cockpit to look at the Devil's Punchbowl and to take pictures. The Devil's Punchbowl is a unique formation in an otherwise highly tilted set of structures. Horizontal stratified rocks have somehow sagged in the center of a high plateau to form a huge bowl. It is difficult to judge distances from the air, but I should guess this rectangular basin is probably two miles long by one mile wide and is raised above the surrounding jumble of pressure ridges about 1,000 feet. It is probably above 3,000 feet in elevation because the inside of the bowl is covered by a comparatively thick forest, indicating a higher rainfall than the lower surrounding country.

It is remarkable how little flat country (structurally) one passes over on this particular air route. Much of it is composed of metamorphic and younger rocks which have been tilted into almost vertical positions and then folded until they look like a gigantic mass of dough that has been stirred with a big spoon.

About half-way to our destination we passed over one end of Lake Eyre, one of the largest dry lakes in interior Australia. Some of its smaller arms have been cut off by drifting dunes but it is so large that even from 18,000 feet its far side disappears on the horizon. Beyond Lake Eyre we looked down on hundreds of square miles of streamer sand ridges that extended in a direction parallel to our line of flight. Most of these long sand ridges have some vegetation and although only the larger trees could be seen from the air (18,000 feet) we were told that spinifex forms a partial covering on most of them.

On the flats between the dunes we saw occasional crescent dunes with sharp edges and steep frontal slopes indicating that they were

active, moving dunes; but nowhere did I see any large sand dunes which had grown into a chain of hills such as one sees in other parts of the world. In Imperial Valley, California, for example, the sand has accumulated into a continuous chain of sand hills which is some 20 miles long by five miles wide and with individual crests rising more than 200 feet above the surrounding plains. These dunes are so active that nothing but a few small plants manages to grow on them. The Sahara Desert and the Arabian Desert both have thousands of square miles of dunes which have grown into chains of hills; big dunes with little dunes riding on their backs like the little waves on the backs of the big storm waves at sea. These dunes are certainly the product of the winds. There can be no argument; they are active. The origin of the sand is another matter.

The Australian sand ridges and the other irregular variety I saw later when flying from Darwin to Mount Isa have a uniformity of height and distribution that is unique. It is impossible, of course, to do any more than guess at the width of a sand ridge from the altitudes at which the commercial airlines fly, but as you cross over and look down on a dozen ridges at once the eye can tell that they are all about the same width and consequently must be quite uniform in height. The sand ridges often divide into two streamers and in the course of a mile or two, rejoin into one. In other areas I saw the parallel sand ridges gradually merge into dunes of the most intricate of pattern. I took pictures of some of these while crossing the Barkley Tableland. Some remind one of the tracks of birds, if bird tracks were ridges instead of depressions, and others look like the hieroglyphics of some forgotten race of giants. Looking down on the Barkley Tableland I estimated that the area covered by sand was from 20 to 30 per cent of the total area.

Jutson, in writing in Geological Survey Bulletin 95, Page 119, goes

goes into considerable detail in describing that part of Western Australia known as "Sandland" or "The Sand Ridge Division."

One of the most remarkable characteristics of the interior of Western Australia is the enormous development of sand-ridges which extend from the northern edge of the Great Southern Plain northwards to Kimberley, and eastwards to the South Australian border, from a line drawn near Condon on the North-West Coast through Eristoun and thence Southwards....This sand ridge country passes into Central and Southern Australia, the whole area being referred to by Griffith Taylor as the Western Desert. It occupies about 440,000 square miles, of which much the greater part is in Western Australia.

It should be said that Bulletin No. 95 was written in 1929 and according to the Preface of the Second Edition, "No substantial alteration to the manuscript has been made since that time." It contains no aerial photographs and all quotations of older geological expeditions are based on observations made from the ground when they traveled by camel train. The ground observer gets better detailed information but his over-all picture is only a small part of what the airborne observer sees.

Quoting again from Bulletin No. 95, Page 120:

"The general trend of the sand ridges north of latitude 26 degrees south, except in the proximity of the ranges and hills, is west-north-west (Talbot and Clarke, Kearthland, and Carnegie). Clapp in the northwestern portion of the division records their direction as between S-75-W and N-75-W. To the south of latitude 26 the sand ridges in different areas may run in different directions, although in each area they are approximately parallel (Talbot). The irregularity in direction is ascribed to the variableness of the winds south of latitude 26 degrees S. North of that latitude the ridges are parallel to each other and to the direction (E-S-E) of the prevailing wind, the trend of the ridges being due to that wind. Where, however, in this northern area blown sand occurs in the vicinity of ranges and hills, the sand is heaped up into a jumble of hills and ridges which have no particular direction (Talbot). The remarkable parallelism of the sand ridges over wide areas, even, as shown above, where the directions are different in different areas, is noted by all of the authors mentioned above."

"The height of the sand ridges varies considerably. In the north-western portion they range from a few feet to sixty feet in height (Clapp). Carnegie notes that in one part they are from 30 to 50 feet high, while in other places they have an average vertical height from trough to crest of 50 to 60 feet, and that though some are mere rises, others attain a height of considerably over 100 feet. Wells also records sand ridges

100 feet high. Between Laverton and Townsend Ranges the sand ridges have an average height of about 30 feet and one, Streich Mound, rises to a height of 150 feet (Talbot and Clarke)."

"The length of the ridges also appears to vary much, but there is little recorded information on this point. In the north-western portion they are very persistent, and few of them have any ascertained termination (Clapp)."

"The width of the ridges is also variable, so far as our scanty knowledge permits any statement to be made. In the north-western portion, they vary from 150 to 1500 feet (Clapp)."

Jutson says that the separation between ridges is very unequal.

"Carnegie states that in places the ridges were a quarter of a mile apart, but in other parts ridge succeeded ridge like the waves of the sea, and on one day he was crossing them at the rate of ten in forty minutes. Keartland notes that in regard to the sand ridges farther west, they were so close together that the leading camels in the caravan were ascending a ridge before the last of the team had descended the previous one."

(A pleasing word picture, but how long was the camel train?)

"The vegetation of the sand ridges is distinctive. On those along the Canning Stock Route there is usually a fairly strong growth of vegetation consisting of desert gums, shrubs of various kinds, spinifex (*Triodia*) and sometimes grass (Talbot). Carnegie refers to the ridges as being overgrown by the "hateful spinifex" and timbered pretty thickly with desert gums and low acacia bushes....In the sand ridge country between Laverton and the Townsend Ridge spinifex predominates. Desert gums grow on the ridges and the intervening flats, and mallee and mulga also grow on the flats but are not seen above the base of the ridges. *Parakylia* grows luxuriantly (Talbot and Clarke)."

"So far as know, the sand ridges are composed practically entirely of quartz which has been derived partly from granite but chiefly from the vast area of sedimentary rocks of Nullargine, Permo-Carboniferous and Cretaceous age. Very little attention hitherto has been given to the mineral composition of the sand ridges, and the size, shape and general characters of the component grains. Studies on these lines may be looked for in the future."

In regard to the movement of the sand ridges, Jutson quotes the same geological authorities (Carnegie, Talbot and Clapp) as agreeing that except for the western edge of the sand belt the sand ridges are stationary--Page 122:

"In the same publication Talbot notes that the sand ridges appear to be practically stationary, that there is little manifestation of erosion of the sand ridges, that there is a movement in the grains of sand on the ridges, but that the sand appears to be deposited as fast as it is removed, and that the

stability of the sand ridges is due entirely to the covering vegetation, amongst the types of which spinifex is the most important in restraining movement of the sand. Carnegie records that the spinifex serves to bind the sand and keep the ridges for the most part compact. Clapp observes that sand ridges are still being deposited over large areas of the interior."

Jutson terminates the sand ridge section with the following, Page 123:

"It may therefore with some degree of confidence be maintained that, although the ridges away from the western margin are relatively stable, yet there is probably a steady, if slow, westward movement of the ridges. These remarks are intended to apply only to the ridges north of latitude 26 degrees South."

It should be noted that latitude 26 degrees South constitutes the border between South Australia and the Northern Territory, the latter being then a no-mans-land which anyone might explore or talk about with impunity. The facts are that the sand ridges extend over a great part of South Australia, even down to the southern ocean as described earlier at Kyancutta on the Eyre Peninsula. Also some of the sand ridges extend into the southwest corner of Queensland where it (the corner) is located in the center of the Simpson Desert.

Apart from political subdivisions, the Great Australian Desert is a great square averaging 1,100 miles north and south by 1,150 miles east and west, an area of 1,148,200 square miles, or nearly half the continental area of Australia. Sand ridges do not cover all of this area because of dry lakes and mountains, but they cover certainly more than half of it.

It will be noted from the above quotation that Jutson and his colleagues take it as a foregone conclusion that the sand ridges were made by wind, but nowhere do they state that sand ridges are being made by wind today. Even Clapp, who makes the only positive statement, says they are being deposited now but he does not use the word wind, only implying it. Also they all admit that the vegetative cover is now in place on the ridges and therefore that the present winds are not sufficient to move sand. Nor do they consider how wind might have ever produced these long streamers of sand which extend

straight across the desert for miles and miles with only slight variation in their height and width.

Jutson does not mention the small crescent-shaped dunes which I saw in several places between Lake Eyre and Alice Springs. These were on the hard desert floor between the sand ridges, and from horn to horn the largest appeared no wider than the sand ridges on either side. In this particular area the planes fly parallel with the highway and railroad which can be seen below much of the time. Estimating the width of the graded road at 30 feet, I judged that the sand ridges were about 10 times the width of the road and that the strips of bare ground between the ridges were from four to five times as wide as the ridges. There was considerable variation from place to place but I think these widths would be typical: The ridges average about 300 feet in width while the bare strips between are, on the average, about a quarter of a mile wide.

A few chapters ago I asked the Australian geologists to go into detail and explain how the lakes and sand ridges were migrating, and now it is my turn to try to explain, in detail, how cosmic collision and oceanic flood could have produced them.

First, I think we can agree that only wind and water can move sand and arrange it in any sort of pattern. We must ask ourselves, then, could wind produce long parallel ridges of sand? Even assuming that they were once free of all vegetative cover, could winds strong enough to move sand produce these parallel ridges? I think not. I feel quite sure that if strong winds of, say, 40 to 60 miles per hour were to start to blow along these sand ridges as they are now, and I mean parallel with the ridges as Jutson indicates they blow now, the ridges would be cut to pieces and a sea of active moving sand dunes would result. Trees and shrubs are no barrier to moving sand if the winds are strong enough and continue long enough.

If wind did not build the long string dunes or sand ridges, how did water produce them? Obviously we must rule out rivers. There is not even a remote possibility that thousands of parallel rivers could have built parallel sand bars between them in a flat country. That leaves the ocean. If it were the ocean, we can eliminate slow emergence because in that event shoreline breaker action would produce a leveling effect. A common example is the beautifully leveled sand beaches which are produced by outgoing tides, especially extremely low tides, with leveling so perfect that the hard sand beaches make perfect race tracks.

For the sake of speculation we might consider that the great central desert of Australia was once a shallow basin below sea level which slowly emerged; that somehow prevailing winds blowing across this shallow basin of sea water produced a wave motion which built parallel sand bars beneath the water. In certain areas, like the Barkley Plateau, the prevailing winds from one direction might have met other prevailing winds from another direction and produced a chop in the wave motion which in turn produced the irregular sand ridge pattern on the bottom. We might consider that this shallow basin was finally raised entirely above sea level and in the course of time the water evaporated, leaving the final salt lakes scattered over the basin and the sand ridges as made. The difficulty, however, is to explain how the slowly evaporating water could protect the sand ridges from the leveling effects of wave action. The water would need to remain glassy smooth for ages while the sand ridges emerged as the water evaporated.

I stood on the shore of Lake Mead (Hoover Dam) when it was first filling and watched the waves reduce by under cutting erosion in one afternoon, a sand island 10 feet high, 200 feet long, and perhaps 50 feet wide. The wind was blowing perhaps 25 to 30 miles per hour and

kicking up whitecaps, with waves two or three feet high ~~were~~ breaking against this soft sandy material. The lake was slowly rising, but not more than one-quarter inch per hour; nevertheless ^{this} ~~these~~ island completely disappeared in less than four hours. Certainly we cannot believe that the water in the Australian basin could have remained glassy smooth.

In searching my mind trying to think where I have seen water produce sand ridges, I recall tidal flats near Carlsbad, California where the water rose and fell about two feet, leaving in certain locations small parallel sand ridges or ripple marks that were about two inches high and perhaps eight inches from trough to trough. This sand packed very hard and when the tide was out, one could walk over it scarcely leaving the sign of a footprint. The water moved off of this sand without destroying the sand ridges.

Again, I remember a beach of very coarse granitic sand at the tip of Baja, California near Cape San Lucas where very large ripple marks were found in about three feet of water. The red granite of this coast decomposes into a very coarse angular sand with individual grains being often a quarter of an inch on a side. There is very little change of tide here and very light wave action, the water merely surging up and back on a steep beach with a run of perhaps ten feet. ~~A little distance back on a steep beach with a run of perhaps ten feet.~~ A little distance from shore, possibly fifty feet, where the water was about three feet deep, this coarse sand had accumulated into parallel ridges with troughs about a foot deep and a distance from crest to crest of about four feet. Walking over this bottom was quite difficult, but swimming over it with skin diving equipment gave a good view of the ridges and troughs. Because of the very slight tidal change at this location, it is doubtful if the ridges are uncovered very often, but I have no doubt that they would remain. Such coarse sand

is more easily moved by water because the water penetrates the sand and produces a floatation that is not possible where the tiny grains of sand pack so tightly that no space is left between for water.

The long parallel dunes of Australia are composed of fine sand which I suspect was moved into place by the more violent action of oceanic flood waters. When this violent stage subsided, the area being very flat, the waters moved off quite slowly or evaporated where they were so that the hard-packed wet sand was quite resistant to erosion.

Shallow streams flowing about as fast as a person can walk will make sand ridges or mounds on the bottom which match the waves above. As a farm boy I learned this by wading in the creek after rainstorms. Anyone who has stood on the bank of such a creek and watched a long row of waves slowly marching downstream knows that the waves in the sand below, which ^{are made by} ~~make~~ the waves in the water above, move only about one-tenth as fast as the water. I say only a tenth as fast, but I am only guessing because I have never measured it, and in all of the 16 years during which I have been reading geological journals and books, I have never seen it discussed. It is one of the simple things which millions of people could have noticed for it can be seen in the tiniest stream only an inch or two deep. It certainly must be in geological literature somewhere for the volume of literature accumulated over the years is tremendous and the portion which I have read could hardly be more than one per cent of the total. My reason for discussing this matter in detail is that I feel it is important in determining how the sand ridges of Australia were made. If little waves can build little sand ridges, large waves can build large sand ridges in the same way.

One important thing to determine is this: Can the sand ridges re-

main undisturbed as the water moves off? And if so, under what conditions? It can happen in tidal basins where the water drains off slowly and where the sand grains are fine and pack together firmly. In creek or river beds, however, where the water slows down gradually before drying up completely, all but the tiny ripple marks are generally erased and, in general, the dry bed of the stream is a series of elongated deltas overlapping each other downstream like the scales of a fish. In a fairly flat stream bed, these may be 10 feet long and only one-half inch thick at their frontal slope. A steeper slope (gradient) will produce shorter and thicker scales. In general, it may be said that the sand ridges developed in any stream will be wiped out by the final stream flow, but there are exceptions. Flash floods can move down a stream bed producing sizeable sand ridges and ripple marks and pass by so quickly as to leave undisturbed the ridges thus made. I have seen this only a time or two, and I photographed its effects in the dry creek bed at Agnew, where we had breakfast one morning. ~~(picture)~~ This was the last stream bed we were to see for the next 1,500 miles and I knew that I might never see another set of ripple marks as large as these during the remainder of my lifetime. It was only a small area, about 40 feet long and perhaps 10 feet wide in a creek bed about 50 feet wide. From trough to ridge, these ripple marks were only about six inches deep and from trough to trough about 36 inches, and all quite uniform in size over the small patch of sand in which they were located. The creek bed alternated between patches of rocky gravel and sand and had a fairly steep gradient. The final runoff from the flash flood which had produced these ripple marks was of very short duration and followed a narrow path along one side of the creek bed, cutting off only one end of the sand ridges.

From the above observations we must conclude that wave motion

in water produces waves in the sand beneath which are parallel to the water waves and, therefore, the sand ridges in Australia could not have been made by water moving in the direction of their elongation any more than wind blowing parallel to them could have made them.

Let us consider the last major collision which we believe to have occurred near the island of Bermuda about 11,000 years ago. In Australia, which was nearly 180 degrees away from the point of the impact, oceanic flood waters reacting to the movement of the earth, surged over the continent. Because the initial direction of the earth's movement was to the southeast, the inertia of the water caused it to appear to move in the opposite direction, probably with a slightly curving motion because this movement was the product of two motions: The rotation of the earth about its axis and the striking direction of the meteorite. The result was a general movement of ocean water across Australia from southwest to northeast, followed by a return in the opposite direction and then a general readjustment of water, the whole pattern disturbed by shock waves which must have traveled around the earth through the crust and perhaps through the core of the earth. In my opinion, such shock waves could have caused the wave pattern on the water which was repeated in the sand ridges on the bottom, at the same time stranding the icebergs which produced the lakes. The water must have drained away very slowly.

We landed at the Alice Springs airstrip about 10:30 a.m. and were met at the gate by Mrs. Jones, wife of the state geologist stationed at Alice Springs. She took us into town (a distance of about four miles) all of us packed into a small Holden sedan along with our baggage and three small Jones children. Mrs. Jones tried to find us accommodations in the new hotel just completed, but it was booked solid, so she took us to the next best place, a new hotel near the center of town.

Alice Springs is the one and only town of any size in central Australia. It is the hub of the wheel, and airlines, roads, and railroads meet at this center. Since it is the center of the mining and the livestock industries, practically all business from within 300 to 500 miles is brought there.

Most of the surrounding cattle and sheep stations contain from 500,000 to 1,000,000 acres and the headquarters at each station is something like a small town with the families of native workers living there along with the whites. The Connellen Airlines has been flying in this region for something like 20 years. The first part of the week they fly a 1,500-mile loop to the stations northwest of Alice Springs and the latter part of the week a smaller loop to the northeast stations as far as Mt. Isa where they make a connection with Australian Airlines flight from Darwin to Brisbane. Each ^{sheep or cattle} station in the area has its own airstrip so that it received regular weekly mail service. Fresh food and other supplies are also regularly flown to the stations from Alice Springs. With the "Flying Doctor" and the "Flying Dental Service," a modern version of the old country doctor, traveling by airplane instead of horse and buggy, life on the Australian frontier is not as rugged as it was before the airplane and the jeep came on the scene.

The town of Alice Springs lies in a rather unique setting, just inside a double wall of rocks which stretches across the desert east and west as far as the eye can see. These walls of rock are about a half-mile apart and perhaps 300 feet high and are composed of hard quartzite beds which have been tilted at an angle of about 45 degrees. Two water gaps, directly in line with each other, form a double gateway to the town for railroad and highway. The inner gateway is called Heavy Tree Gap because of the unusually large eucalyptus trees growing along the stream bed. The stream flows out of some low granite hills to the north of the town and at the edge of these hills is a pond

of green slimy water. This is the original Alice Springs, after which the town was named. The paralleling ridges form a sort of double dyke which brings the water from either side toward the gaps and produces one of the few underground basins of fresh water found in interior Australia. The town water supply is pumped from this underground basin to a tank on the top of a low granite hill near the west side of town.

Alice Springs has many nice gardens and an unusual number of shade trees because of the adequate supply of water which other interior Australian towns lack. From the veranda of our hotel, I made a list of the various kinds of trees that could be seen in the yards nearby, and they included: carrab, pepper, umbrella, oleander, Italian cypress, lemon, grapefruit, orange, apple, apricot, and eucalyptus.

The outstanding landmark at Alice Springs is a white marble shaft (at the top of another low granite hill) which was erected in memory of local war dead. It is indirectly lighted at night and seems to float above the city in the darkness of the night sky.

On our first evening in Alice Springs we were invited to the home of Mr. Douglas Boerne who had heard of our interest in meteorites and who had, himself, a very keen interest in many phases of natural history. He showed us his collections of meteorites, native weapons and artifacts, and local minerals, including opals and gold specimens. While we were there an Italian opal miner and his wife dropped by to visit. They were recent immigrants from Italy and had made a small fortune by a lucky strike at the opal mines some 100 miles to the south of Alice Springs. They told us that the miners live in caves which they dig out of sandstone formation in which the opals are found. There is no telling, it seems, when or where an opal pocket will be found--it is just a matter of luck--and since the mine is the coolest place to live the miner simply expands his home from day to day hoping to strike it rich. Gem-quality opal is worth from \$60 to

480 per ounce and American buyers are on hand most of the time to buy. Many of the miners are aborigines and in 1957 one lucky family found an opal worth \$180,000.

Included in Mr. Boerner's fine collection of native weapons was a recently acquired stone axe made by one of the really wild native tribesman who still roam the desert some 300 miles to the west of Alice Springs. These natives go stark naked and roam from place to place, sleeping in the open wherever night overtakes them. These stone-age people still make their weapons as of old. This axe head was shaped and polished and the cutting edge was smooth and sharp, not flaked and jagged as our American Indians made them. The head was hafted into a split stick about 10 inches long, the handle having a section about one-quarter inch wide taken out of the center so that the sides could be sprung together a little and bound with kangaroo sinew. The sinew was then covered with spinifex gum and finally bound with a braided cord made from human hair and decorated with a small tassel. The strands of the cord are rolled from human hair by using the flat of the hand against the thigh. Mr. Boerner said that it may take a native as much as six months to make such a stone axe, the grinding and polishing being a very slow process, but time means nothing to an aborigine.

The message sticks and spear-throwing sticks made by these people are decorated with intricately carved patterns which must have taken weeks to produce. I was given a spear-throwing stick which is carved in four dimensions. It is an elongated blade 35 inches long and four inches wide near the center, concave on the upper side (which holds the spear in throwing position) and convex on the lower side. The lower side is smooth but the upper side is decorated with 12-U-shaped designs carved into the wood and they in turn are covered with dozens of tiny grooves which zig-zag the entire length of the stick over and across the larger pattern. ~~(photograph)~~. The handle end of the throwing stick has

a ball of spinifex gum moulded to it to fit the hand. The other end has a fishhook-like wooden point bound to it with kangaroo sinew; this fits into the rear end of the spear. How the aborigine is able to throw a spear with such a stick is beyond my understanding, but they are said to be very accurate with them. When hunting kangaroo they throw the spear very low, often bouncing it off the ground, because the great bulk of a kangaroo's body is close to the ground when it is sitting on its haunches and so much easier to hit than the smaller front quarters and head.

The boomerang is a very formidable weapon, too. It is cut from a curved branch of heavy mulga wood and thinned down until it is only about one-half inch thick at the thickest part of the blade. The ends are rounded and sharpened to a cutting edge, as is the length of the blade, so that when thrown end over end it will cut or penetrate whether edge or point strikes first. These hunting or fighting boomerangs are usually about 30 inches long and only slightly curved, for they are intended to be thrown straight. The sharply curved boomerangs are only playthings, made to return to the thrower, and are never used in hunting. Even the aborigine, it seems, must have his recreation. *playing with returning boomerangs.*

Mr. Boerner had made many trips to the Henbury meteorite craters to look for meteorites, and he offered to accompany us there whenever Mr. Jones, the state geologist, could get the necessary Land Rovers ready for the trip.

February 27, 1959:

In order to see the town we rented a car and headed for the new residential suburbs where we saw some of the most modern homes we had seen anywhere in Australia. Many of these new homes were built on stilts some seven to eight feet tall. This has a cooling effect and provides a space under the house to park a car or hang out the laundry.

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We had been advised at the car rental agency not to miss visiting a local artist, ^{Rex Battarbee,} who had a fine collection of aboriginal art at his home. ^{Battarbee} ~~The artist,~~ had come to Alice Springs many years before for his health. On a whim, he had persuaded one of the local blackfellows to try water color landscapes and the man had showed such talent that he was soon equaling the work of his teacher. Since then this artist has taught many of the natives to paint with water colors and has developed some outstanding artists. Some of the best pictures he has had reproduced in England and now sells the prints to tourists, making money for himself and the native artist as well. The quality of this native art is remarkable as to detail, accuracy of color, and perspective. It shows that primitive man has strongly developed artistic talents and is perhaps able to observe nature in more detail than his more civilized neighbors.

Earlier in the day Dr. Nininger and I had arranged with Connellen Airlines to be flown out to Lake Eaton, the feature which I suspected of being a meteorite crater and which I had come half-way around the world to see. At the airport, about three miles west of town, we met our pilot who showed us his maps and explained the flight plan. He had never been to Lake Eaton, it being far off the regular air route to Sturt Creek, but we were to make the first stop for gasoline at Mr. Connellen's cattle station about 100 miles from Alice Springs and get final instructions there. Mr. Connellen had retired from active flying but he had started this airline as a bush pilot of long experience and was well acquainted with the Lake Eaton area. (picture)

Our plane was a little three-place Cessna which had been loaded with extra gasoline and some food, water, and several bottles of lemon squash in case we were forced down for some reason. Everyone travelling in central Australia in the summertime, as we were, takes along extra food and water and leaves word for his friends to look for him if he

is not back by a certain time. However, we had a two-way radio and so felt quite safe.

The air was very bumpy as had been predicted and reminded me of riding over rough country roads in an old springless farm wagon in my childhood days. As we circled over Alice Springs our pilot pointed out a little pond of water in the creek bed which he said was the original Alice Springs. We turned west along the backbone of some low granite mountains and soon passed over a station called Hamilton Downs. It is a cattle station run something on the order of an American dude ranch. It lies in a canyon between some rough granite hills and a more uninviting place for a vacation I cannot imagine. The only thing of interest is that it lies almost exactly on the Tropic of Capricorn.

✓ To the south we could see the rugged peaks of the ~~Macedonell~~ ^{MacDonnell} Range and two water gaps where the Finke River cuts through them in what the Australians consider ~~the~~ ^{the} spectacular canyons. The highest peak in this range is Mt. Sonder which is 4,417 feet, but the main part of the range is about 2,700 feet, rising only about 1,400 feet above the surrounding plain. We were soon in sight of the Connellen air strip which could be seen for a distance of perhaps 40 miles, so we were not in any great danger of getting lost. Sketch

Upon landing we were met by Mr. Connellen himself, a tall Australian ^{whose} ~~who~~ hair had once been red and whose face and hands looked as if he had fought the furnace-like winds of the desert for 100 years. He pumped the gas out of a 50-gallon drum standing by the side of the field while he explained to our pilot how to get to Lake Eaton. Why anyone would want to go there he didn't know and as for it being a meteorite crater he had seen no evidence that would lead him to think so.

Off to one side of the landing strip a few hundred yards we could

see someone building a small corrugated iron shed, and still farther away, near a windmill, was a little shack made of railroad ties or some kind of timbers stood on end. This was the cattle station headquarters. There was nothing else in sight. We were on the edge of the Semi Desert, a barren waste of parallel fossil dunes and dry lake beds that extend in all directions from Alice Springs and the ~~MacDonnell~~ ^{MacDonnell} Range, except to the southeast where it is called the Simpson Desert. Why this 1,000-mile-wide waste of sand and rock and furnace-like heat is called the Semi Desert, I shall never know. It had all of the earmarks of a full-blown desert so far as I could see.

We were soon off the ground again and headed for Lake Eaton, or Lake Bennett, as it is sometimes called. I would soon know whether this feature which had attracted my interest so firmly was a true meteorite crater or not. Certainly the photograph taken by the Australian airforce had indicated that it was. But alas! Our little plane flying at 1,500 feet revealed that things were not as they had seemed from 25,000 feet. What had appeared in the photograph as circular faults were low sand dunes; the radiating faults, dry creek beds, the high cliffs were not there at all, only a low sand rim perhaps 20 feet high and the central peak with its little crater in the top was only a low central salt pan with a still smaller salt pan within its circle. The smaller surrounding craters were only shallow salt pans. There was no mistaking the evidence; no need to go to the ground for verification-- the physical facts were all too plain. We had spent time and considerable money for negative information, a kind of scientific achievement which has its rewards, I am told.

On the way back to Alice Springs we took a route somewhat to the south of our outbound journey, passing a little closer to ~~MacDonnell~~ ^{MacDonnell} Range. The flat part of the Semi Desert is covered with a thin scrub and the white trunk of an occasional ghost gum could be seen from our

altitude. A few lonesome cattle trails heading for a solitary windmill could be seen far below and in the blue distance the pilot pointed out a native settlement called Haasts Bluff where the Australian government provides some food and clothing for any aborigines who may want to come and live there. The government, he said, was spoiling the natives by feeding them and that most of the government men stationed in these far-out places were misfits who couldn't hold a job elsewhere. He likened it to our American Indian Affairs Service which he seemed to have heard about.

Nearing home and safety we decided to eat the lunch and drink the lemon squash. The air was still very rough and it was a real chore to drink out of a paper cup. The pilot poured the drinks with great dexterity, hardly spilling a drop, but I lifted the cup just as we hit a bump and spilled most of the contents down my shirt front.

P As we passed close over the tops of some of the mountains we noticed that the spinifex had been recently burned and our pilot told us that the cattle growers burn it periodically to make young and more succulent feed for the cattle.

We arrived back at Alice Springs about six o'clock. Later in the evening the pilot took Dr. Nininger to meet a friend who had a few small Henbury irons. The next day was to be our day at the Henbury craters.

February 28, 1959:

We left the hotel about 7:30 a.m. in two Land Rovers, the one driven by ~~ME~~ Neil Jones, Alice Springs resident geologist, carrying Dr. and Mrs. Nininger, and the other driven by a Bureau of Mines mechanic, carrying Mr. Douglas Boerner and myself as passengers as well as extra supplies of water and gasoline.

The Henbury meteorite craters lie to the south and west of Alice Springs a distance of 96 miles. The road is quite passable, being a

main road connecting Alice Springs with a number of outlying mining camps. The craters are situated only a mile or two off the main road and since most of the area is desert pavement, one can drive almost anywhere over it in a vehicle such as a Land Rover. This desert pavement looks very much like that found in the Colorado Desert of California and Arizona. It is formed of individual stones not much larger than hen's eggs, some being smaller. They are mostly broken quartz and greenstone lavas with many small pieces of thin-bedded sandstone mixed in, resulting in a hard-packed pavement which glistens in the sun as if it had been glazed by heat. Actually the polish on these stones is probably due to wind-blown sand. The color is a brownish red.

The Henbury craters are situated on the northeast side of a low sandstone ridge which rises about 300 feet above the plain. The strata in this ridge are nearly perpendicular and so finely bedded that scarcely a stone can be found which is more than an inch or two in thickness. There are 13 craters in all scattered over an area of little more than a square mile, and four of these are in a group with their rims touching. The largest is elongated, about 650 feet long by 350 feet wide, and is very likely the product of two large irons striking close together. This observation is strengthened by the fact that two other well defined craters join the rim of the large elongated one (see Fig. IV). One of the striking features of this group is the conformation of the out-thrown debris which is arranged in irregular streamers of varying size. Judging by the distribution of this debris, the meteorites came in from the northeast at something near a 45-degree angle, most of the debris being blown back out in a north and northeast direction. The highest part of the crater rim lies on the southwest side with a very short ridge of rock debris beyond it. The two smaller craters show no streamers, but appear to have pinched back the rim of the big double crater making that the high part of the rim. Much the greatest volume of material was

blown out on the northeast side of the crater and a small secondary hill of rock flour (Note: Rock flour is a finely pulverized dust of native country rock that has been found in or around most of the large known meteorite craters) within the northeast side of the main basin marks that side as the direction in which most of the explosive force was expended. The fact that this mound of rock flour remains inside the crater rim and that the rim on that side was not blown off as it was at the Dalgaranga crater, indicates that the projectiles must have come in an angle of at least 45 degrees or higher.

When we arrived at the craters everyone started looking for meteorites. The small bush flies were swarming about each person's head and we were fighting them out of our eyes and ears with our handkerchiefs and brush switches. I had no luck at first so decided to circle the craters at some distance and then walked up on the sandstone ridge to the south for a look over the whole area. (It was from here that I made the accompanying sketch, Fig. XV). I had hoped to find a larger specimen which had been thrown to a greater distance, but no such luck. The area has been thoroughly searched for many years and it is said that more than 1,000 pieces of meteoritic iron have been found here, the total weighing over 3,000 pounds.

On returning to where the rest of the party was searching I found that all had had some luck and after some instruction from Mr. Boerner I began finding them too. We searched for about 2½ hours and I recorded in my notes that the six of us found a total of 90 meteorites of pea size or larger. Neil Jones found the largest one, an iron about the size of two walnuts joined together, and Dr. Nininger gathered a great many small ones down to mere specks with his magnet rake. As the search went on my eyes became more accustomed to what to look for and in one place I found more than a dozen, ending the day with 42 meteorites, several pieces of oxide (rusted meteorite) and some nice

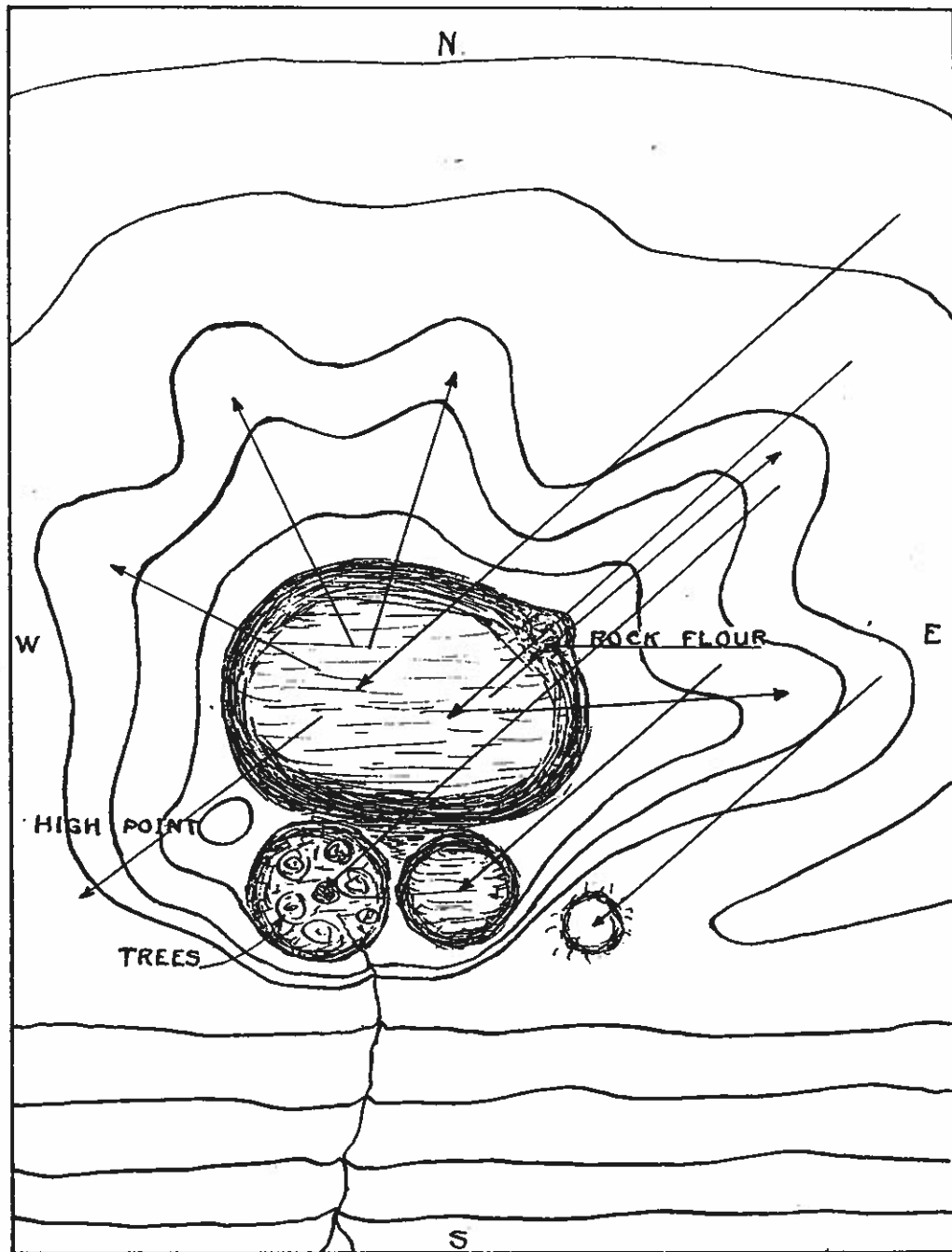


Fig. XV. HENBURY CRATERS.

Sketch made at craters showing approximate size and shape of the largest of the Henbury group. The other nine of the thirteen craters are scattered over a considerable area to the southwest. Arrows indicate direction of approach as deduced from the distribution of ejectamenta.



specimens of impactite (chunks of sand fused by the heat of impact and impregnated with bits of the melted meteorite).

About 1:00 o'clock, Neil Jones drove the Land Rovers down into the second-largest crater which was filled with trees large enough to provide a pretty good shade, and there spread out a lunch and built a small fire to boil some coffee for the Americans. The lunch was good but the millions of flies and the 95-degree temperature in the shade made the staying a little rough and we started on our return journey about 3:00 ~~P.M.~~

On the way back we stopped to take pictures of camels which had gone "wild" since the days when camels were the only means of transportation in that country. They were not really very wild, because we managed to get within a few hundred feet of them before they moved away with much moaning and groaning. One old lady lying under a little scrub tree just large enough to shade her head, began the most awful groaning. She was several hundred yards away and was apparently making all the fuss because her baby was too near the Land Rovers. I had no idea that camels could groan so loudly. It sounded like a foghorn on some rock-bound coast.

We saw several kangaroos during the day and the Niningers saw one of the huge lizards which grow to be nearly seven feet long. Our driver was inclined to drive much faster than Mr Jones and so we found time to stop and look for fossils near the Hugh River, a stream bed which actually showed a few shallow pools of water that had accumulated from a recent rain. There were many beautiful ghost gums along this stream bed and it was here that we met a herd of miserably poor and ill-bred cattle which were being moved to better pastures by some aborigine cowboys. Just outside Alice Springs and between the two quartzite ridges which guard the town on the south, we stopped to see the only orange and grapefruit orchard in central Australia.

We reached our hotel about 6:30, content over our day of exploration, but extremely dehydrated. We couldn't get enough water--the Niningers and myself consumed three pitchers full of ice water during the evening. It was stifling hot and not until 4:00 a.m. did it cool off sufficiently that I could get to sleep.

Dr. Nininger is of the opinion that the Henbury craters are probably from 15,000 to 25,000 years old, but to me the evidence of erosion indicates that they are probably less than 1,000 years of age.

It is true that this is a desert area, but it is not an extremely dry desert. It had rained nearby only a few days before we visited the craters and the scrub trees and shrubs indicate that there is a considerable yearly rainfall. Really heavy rains of torrential force may not occur more often than once in 20 years in any given locality, but even one such rain could cause very considerable erosion in the soft walls of these craters with their steep slopes. This interior section of Australia is subject to spot rainfall from individual thunder storm clouds, I was told, and this I was ^{later} ~~later~~ able to verify on my flight from Alice Springs to Darwin when I saw many such rainstorms in progress. Most of them appear to cover little more than a mile-wide strip as the cloud travels across the sky. As our plane came down to refuel at Tennant Creek, we encountered such a storm and saw the water standing several inches deep on either side of the runway. If the ground had not been so level, there could have been very extensive erosion from this single heavy rain, and certainly so if it had fallen on the Henbury craters.

The Henbury craters are probably older than the Dalgarranga crater, however, because we saw no large chunks of ejected rock lying about such as one sees around the latter crater. At Dalgarranga there are many chunks of laterite lying about, which show practically no sign of decomposition and it would seem that such an agglomeration of small

rounded stones, so poorly cemented together, would soon disintegrate, due to the absorption of moisture and the action of heat and cold.

~~(pictures of Daigaranga and Henbury)~~

March 1, 1959:

Neil Jones's home, to which we were invited this Sunday evening, is typical of the older houses in Alice Springs, and while not beautiful is quite well suited to this climate. Square with a screened porch all the way around it, it is protected from windstorm and sun by a heavy canvas awning which can be battened down tight to keep out dust, or raised to form a shade and allow the clean, dry air to enter. The corrugated tin roof is ventilated at the top to allow the hot air to escape. The Jone family had an air cooler which was made in Alice Springs and was unlike any I had ever seen. It was made from a 50-gallon oil drum which was well perforated and lined on the inside with felt. The drum rotated slowly in a horizontal position in a trough of water and an electric fan in the open end of the drum sucked cooled air through the wet felt and discharged it into the house. It was a practical and efficient cooler.

March 2, 1959:

This was the first day of the big "Bang-tailed Muster" which was taking place for the second time in the history of Alice Springs, and which was to be formally opened by the Queen of England pressing a button in Lodon and sending her greetings to her subjects in Alice Springs where she had visited a few years before.

The celebration started with a big parade which was as typically western American small town as anyone could ask. Most of the business firms and government agencies in town had built some kind of float on a truck or old automobile and there were kids riding bicycles and pushing wheelbarrows and coaster wagons. The floats had the usual pretty girls dressed in bathing suits or old-fashioned gowns, and the man in the plug hat and handle-bar mustache sitting in a bathtub. The stage coaches

were there, too, with the mail sacks and the Wells Fargo men sitting fore and aft with their rifles.

Uniquely Australian, however, were the near-naked, painted, aborigine dancers, marching with their speers and other paraphenalia; and the camel trains which had once been the most common form of transportation. They had the world's biggest, too--a huge Rolls Royce cattle truck more than 100 feet in length consisting of a very large truck pulling two trailers and said to haul 100 head of grown cattle. (By comparison, our American cattle trucks with one trailer can haul 34 head of grown cattle.)

The parade must have been more than a mile long and the street was lined with people who had come from near and far, even from the big coastal cities. Most of the latter were professional newsmen, but a few were obviously city folks who had come to see their own "wild west," for Alice Springs is the Australian frontier and the Bang-Tail Muster is to Australia what the Pendelton Roundup or the Cheyenne Rodeo is to the United States.

In the afternoon some aborigine dancers from Melville Island put on a show in a small city park on the northwest side of town. Hundreds of local aborigines were in town, but they were either unorganized or too bashful to put on their own dances. We were told that the Melville Islanders had learned to perform in public during the war when some 400,000 troops had been stationed at Darwin and along the north coast of Australia.

The native dances are interpretative--of the hunt, or some other tribal activity. One was of a stork hunt in which each dancer followed in a line behind the leader in imitation of storks walking in their slow, precise, stiff-legged manner. Then there was a dingo-dog dance in which the dancers wore dog-faced masks. The dancers were naked except for very narrow breechcloths, anklets and head decorations, but they were well painted. As I remember, the group which did the animal

dances was painted all white with black spots and stripes where the dark skin had been left unpainted. The other group, the hunters, had white polka-dots and stripes painted on their near-black skins.

I could see nothing amusing about their dances, but the local aborigines seemed to think they were immensely funny and were laughing most of the time. I couldn't decide whether they thought their relatives from 800 miles to the north were making fools of themselves or if there was some hidden meaning that the white folks didn't see or understand.

March 3, 1959:

Dr. and Mrs. Nininger were to go to the Boxhole meteorite craters today and after their return Dr. Nininger was planning to visit the Wolf Creek meteorite crater which lies some 500 miles northwest of Alice Springs in one of the most inaccessible regions of Australia. I would have liked to have accompanied them on both of these trips but my time in Australia was running out. On my next meeting with the Niningers, back in the States some months later, I learned that the Boxhole trip had required two days and that they had enjoyed the trip and collected considerable meteoritic material. Dr. Nininger had made the trip to the Wolf Creek crater by Land Rover from Sturt Creek station on the Connellen Airlines route. It was a trip of about 75 miles and he told me he considered it the roughest and most tiring trip he had ever undertaken. Most of the distance there was no road of any kind and the mounds of spenifix grass made the going very rough.



CHAPTER XII

STARTING HOME: DARWIN TO SYDNEY

I learned that it would cost me no more to fly to Sidney by way of Darwin than to return the way I had come, so I was quick to take advantage of the chance to see some new territory. Luckily, I got a seat on the plane to Darwin that afternoon.

I have noticed that very few people who travel by air care to look out the windows. Some want to take pictures but only at take-off or landing. By and large only crazy people and some geologists care to spend the whole time looking down at the ground which, in a Viscount and on this particular run, was some 18,000 feet below.

We circled and passed over the ~~Macedonell~~ ^{Macedonell} Range heading out to *stet* the north. For over 600 miles there are endless plains of yellow sand and clay extending to the horizon east and west. These are interrupted at Tennant Creek by a greenstone ridge running east and west. Upon landing here for fuel I could see that this ridge is not much more than 100 feet high and perhaps a quarter of a mile wide. There is still active gold mining here at Tennant Creek but not any important production.

We were soon in the air again and glad to be there. We had landed just at the end of a very heavy rainstorm and when the cloud had passed over and the sun came out again the effect was like a steam bath. As the Viscount climbed for altitude, we could see thunderheads with their falling curtains of rain extending to infinity both east and west. It reminded me of a hall of mirrors where one can see his own image extending to infinity in ever smaller reproductions. The rainy season was beginning and we began to see increasing numbers of green

spots where some rain had fallen within the last few weeks. Within a short time after leaving Tennant Creek, we had passed out of the thunderhead cloud formations and reached our cruising altitude of 18,000 feet. From this altitude the horizon must have been close to 150 miles away but it appeared as a straight line like the horizon over the ocean. A little later we passed over a thick cloud formation and I did not see any more of the land below until we broke through the clouds above the coast at Darwin. We touched down in a heavy rain-storm at 8:20 p.m.

I checked my plane reservations for the trip to Sydney and took a bus to the Darwin Hotel. Only three stories tall, it turned out to be the nicest hotel I saw anywhere in Australia. My room was large and modern, with bath, a big electric fan in the ceiling, and a good bed with a large mosquito net hung over it from the ceiling. Across one side of the room were big louvered windows extending from floor to ceiling and covered with Venetian blinds. I opened all the windows, pushed the bed closer to the ceiling fan, and slept in some comfort on top of the sheet. It was raining, and the lightning was flashing and thunder rolling.

March 4, 1959:

The morning was clear and bright and after breakfast I visited the Office of Mines and met the man in charge, Mr. John Hayes. We talked ^{business of} orthodox and collision geology for about two hours. He told me much about South Africa, where he had been ^{lived} before moving to Darwin only two years before. He had been following the course of meteoritics for several years and told me of the large fossil crater in Orange Free State and the geologist I should get in touch with there in order to find out more about it.

In the afternoon the American manager of the uranium mines took me on a tour of the plant and for a ride around the various open-pit

mines. The first big open pit was worked out and is now used for a reservoir to store water for mine operations. It is 350 feet deep and about 600 feet in diameter, in a relatively flat country. The old pit is filled to the brim and a small stream which once ran across the area now flows in one side and out the other. The mills for the reduction of the ore are on a little rise alongside this lake. Most of the ore is a graphite slate which feels very greasy to the touch, but there are other kinds of ore mixed in with the graphite. In fact, in another open-pit mine about a half-mile distant, a very high-grade copper ore is associated with the uranium to such a degree that the copper recovered pays a good proportion of the mining costs. The open pits were shut down when I was there because their stock pile of ore had become too large to keep under cover, and the ore must be kept dry.

The sulphuric acid used in the reduction process is made right there, at the plant. The manager told me that they had at first tried to ship the sulphuric acid to the mines in tanks but found that so difficult that they had turned to shipping in the sulphur and making the acid themselves.

The end product of this plant, a yellow-colored oxide in the form of chips about one-eighth of an inch in diameter, comes out of a dryer on an endless belt where it is elevated into a bin and then packed into 44-gallon steel drums by gravity. The drums are sealed with a rubber seal and enclosed in a steel hoop which is welded in place making the drum moisture tight. I was told that two-thirds of the output goes to the United States and one-third to Great Britain because in 1952 the United States and Great Britain put up the money in this proportion to develop the mine. The Zinc Corporation, Ltd., operates the mine for the Australian government.

This mine was first discovered by an old prospector who had lived

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in the locality for years. He was married to a half-caste woman and lived in a hut in the jungle. Because of his outstanding ability to consume rum in great quantities, his hangout was known as Rum Jungle. The name still sticks and thus the uranium mines here are known to be located at Rum Jungle. The company town nearby is called Batchelor because most of the men living there at first were sans family. Now, however, most of them have their wives and children housed in nice modern homes built on 10-foot stilts. There is a company store, movie house, bar-lounge, tennis courts, bowling green, and two large swimming pools. It is a beautiful little town in the jungle, with winding streets and beautiful flower gardens. This is not a thick jungle of trees but an open forest with an undergrowth of coarse grass which grows about six feet tall. When this grass is cleared away the bright red soil is capable of growing beautiful flowers and green lawns.

The head geologist at the mine told me that the reservoir for the local water supply was an old meteorite crater some 60 feet deep and 200 feet in diameter. I had hoped to see it, but my guide had had too many beers while I was at the mine and couldn't remember where it was. If there is such a natural crater in this flat country where limestone rock does not occur, it is very possibly of meteoritic origin.

The four-lane highway which runs for 60 miles along the coast on either side of Darwin was built by the Americans during the war. Paved landing strips parallel the highway, with a strip located every five miles. These strips were covered with planes during the war, I was told, most of the minor repair work being done here. The Yanks also improved the Stuart Highway and "sealed" it all the way to Alice Springs, a distance of 850 miles.

March 5, 1959:

At 8:20 a.m. our plane took off in a clear sky for Mt. Isa and Brisbane. We soon left the jungle coast country with its numerous rivers and estuaries and were flying inland over the Barkley Tableland which

stretches all the way to Mt. Isa, an air distance of 820 miles. Near the coast a series of sedimentary ridges roughly parallel the coastline and mount in steps toward the Barkley Tableland. All of them are steeply pitching with the strata practically on edge but so low that they scarcely rise above the intervening depressions. Once the Barkley Tableland is reached all sign of underlying rock formations disappear; nothing is seen but a few dry lakes and vast stretches of irregular sand dunes on a level plain. The intricate forms of these dunes are marvelous to see. It might be said that the uniformity of their irregularity and the irregularity of their uniformity is unsurpassed. No streamer dunes occur here. *These are fossil dunes.*

Charles Laseron, writing of these tableland in his book, The Face of Australia, page 66, has given us this description:

In all this expanse there are no prominent hills or valleys to provide landmarks. Yet it is this absence of feature that provides the clue to its greatest interest. In most regions an absence of hills and valley is due to the wear and tear of ages. The forces of erosion have worn down the mountains until nothing remains but their stumps. Here, in contrast, is a region where, extraordinary to relate, there has never been a mountain since before the Cambrian Period. There has never been a hill or valley. The country has remained a plain period after period, era after era, while elsewhere whole lands have been engulfed by the sea, and the bed of the ocean has been elevated into alpine ranges, not once, but time and time again.

Laseron further states that the Barkley Tableland averages about 800 feet in elevation above sea level and that it is underlain everywhere with limestone which lies undisturbed in its original position of deposition. On the northeast this tableland breaks off toward the Gulf of Carpentaria in an intricate pattern of stream erosion that falls the 800 feet in about 100 miles. (Reference p. 62, The Face of Australia). As one flies across the length of this vast tableland one is indeed impressed by its uniformity. Nowhere else in the world is there anything quite like it. The yellow-brown color of its surface stretches to the horizon in every direction, even at 18,000 feet.

We landed at Mt. Isa to refuel and everyone tried to crowd into the air station which was about the size of a very small dwelling. The heat was terrific, the greatest I experienced anywhere on the trip. The wind coming off the desert was like a furnace and strong enough to raise intermittent clouds of dust. Everyone was glad to get back on the plane and into a reasonably cool cabin.

Mt. Isa is a gold-mining town of perhaps 2,000 people, most of whom live in little tent-sized houses laid out in a regular street grid pattern. There is nothing else except the mining buildings housing the machinery and the smoke stacks of the smelters. The mountain which is called Mt. Isa is truly remarkable. It appears to be about 50 miles long, about a mile wide, and perhaps 200 feet high. Just a long ridge of sedimentary rocks that have broken the surface of the Barkley Tableland in a northeast-southwest direction. As I said, the width is about a mile, but it is really two ridges, the one to the west being about twice as high as the other with a long trough in between. It is in this trough that the town and mines are situated. Gold is found in the greenstone which was intruded at the time these rocks were broken and tilted to their present position. They dip to the northwest at an angle of about 45 degrees.

Beyond Mt. Isa toward Brisbane the tableland continues for about 150 miles to where it meets a north and south formation of white sandstone cliffs forming a highly dissected plateau, which in turn runs into a gradually rising plain of good soil and greater rainfall which supports farming and where finally, orchards begin to appear. This great swell, which is about 300 miles wide, rises to a crest about 100 miles inland from the east coast of Australia and is shown on the maps as "The Great Dividing Range." In reality its crest is only about 2,000 feet

high and the surface traveler would never know when he reached the crest except that a few widely scattered volcanic intrusions rise along its length. These are not true volcanoes but rather volcanic necks or plugs which have been intruded through other weaker materials which have subsequently been removed by erosion. What the rocks may be that underlie the vast expanse of the great swell, I have been unable to ascertain from the meagre geological information I was able to obtain; but in any event they show the effects of great age. Farther south along this great swell, which extends the entire length of the east coast of the continent, between Sydney and Melbourne, I observed granite as the surface rock.

It is 1,000 miles from Mt. Isa to Brisbane and we did not reach that city until near sunset, but I did see that it is a very beautiful city set close against a steep rising coastline and around a fine harbor. After a wait of an hour I caught the next flight to Sydney, and thence to Fiji, Honolulu, and home.



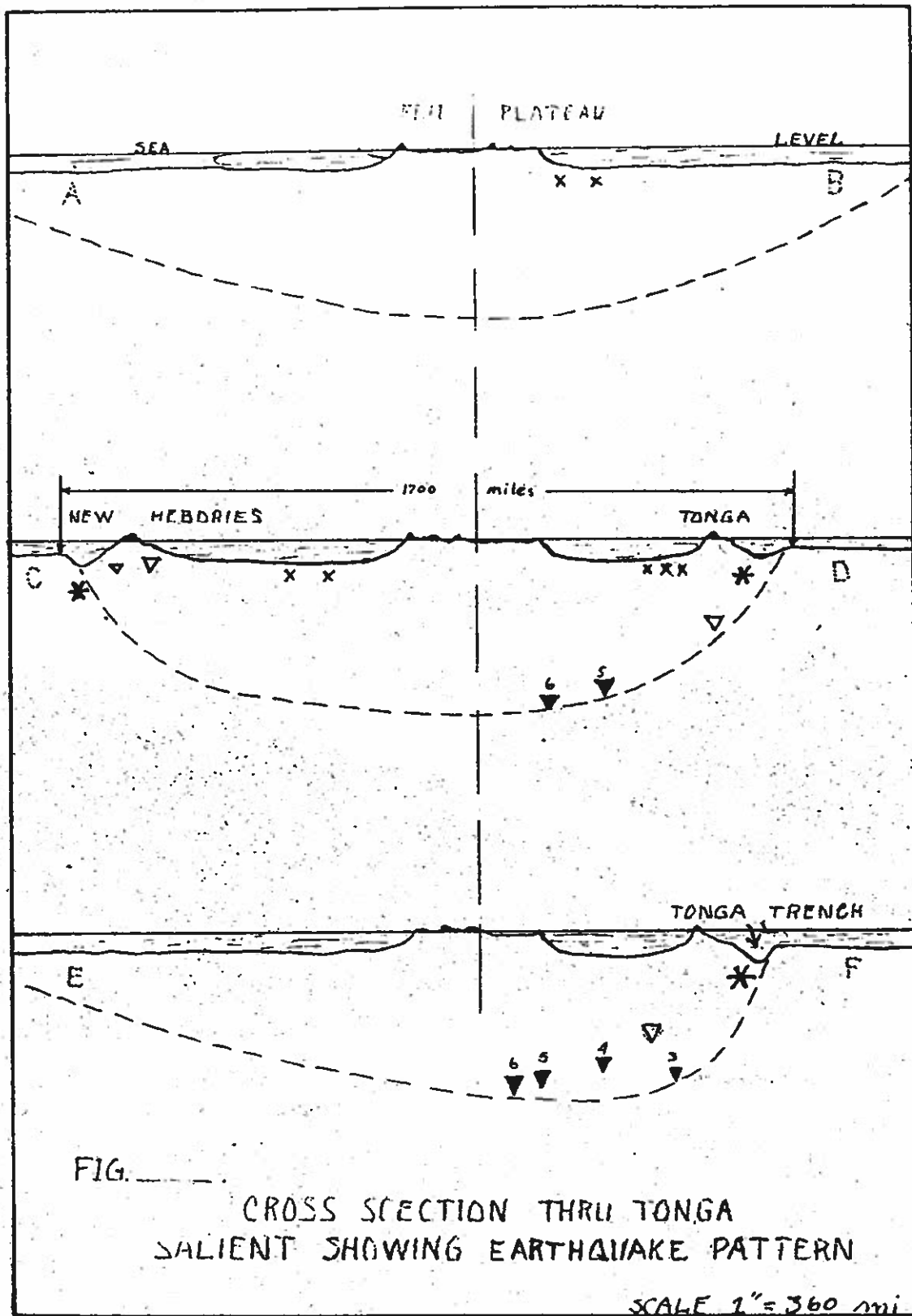
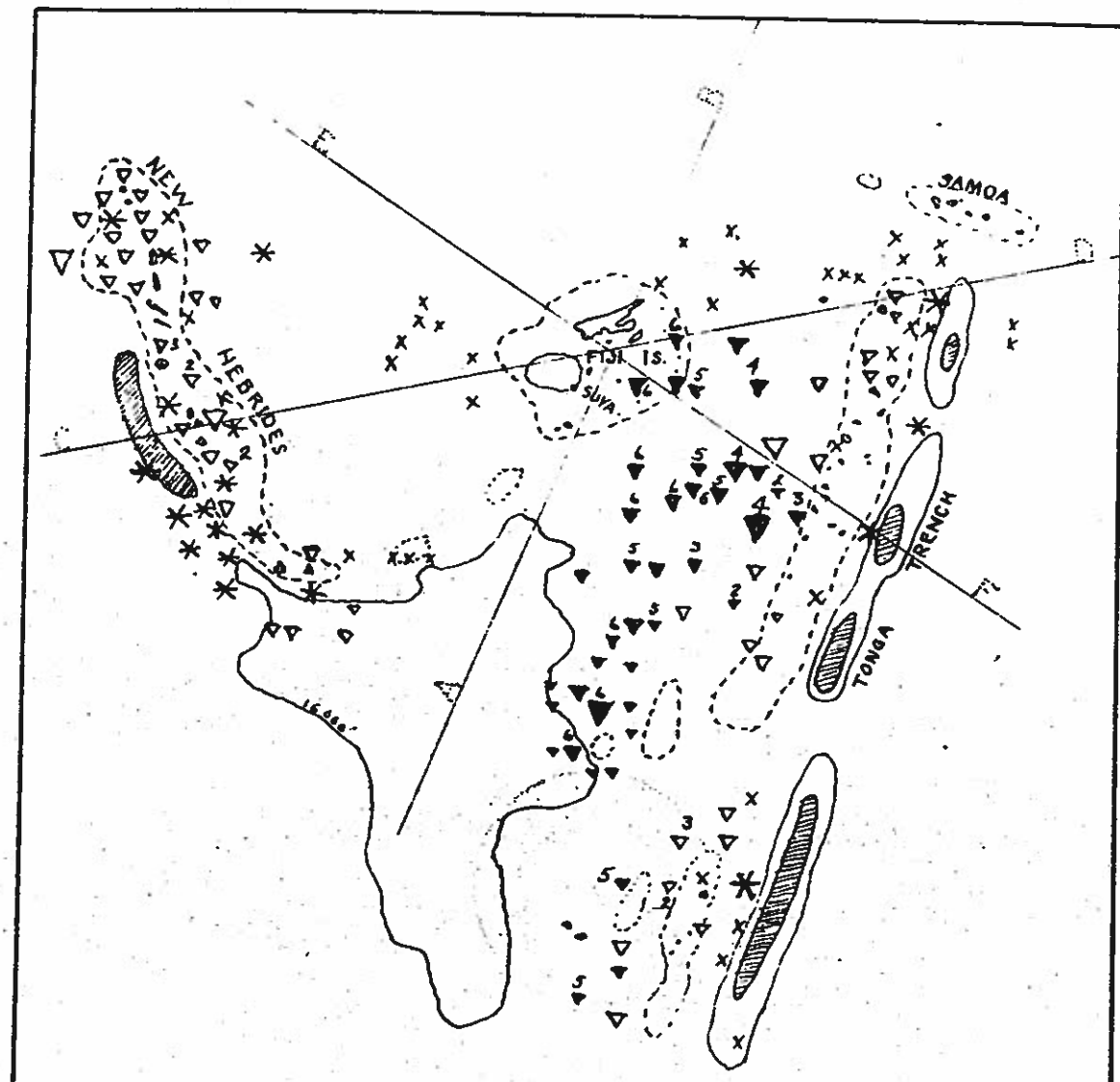


FIG. _____
 CROSS SECTION THRU TONGA
 SALIENT SHOWING EARTHQUAKE PATTERN

SCALE 1" = 360 mi





TONGA SALIENT EARTHQUAKE PATTERN

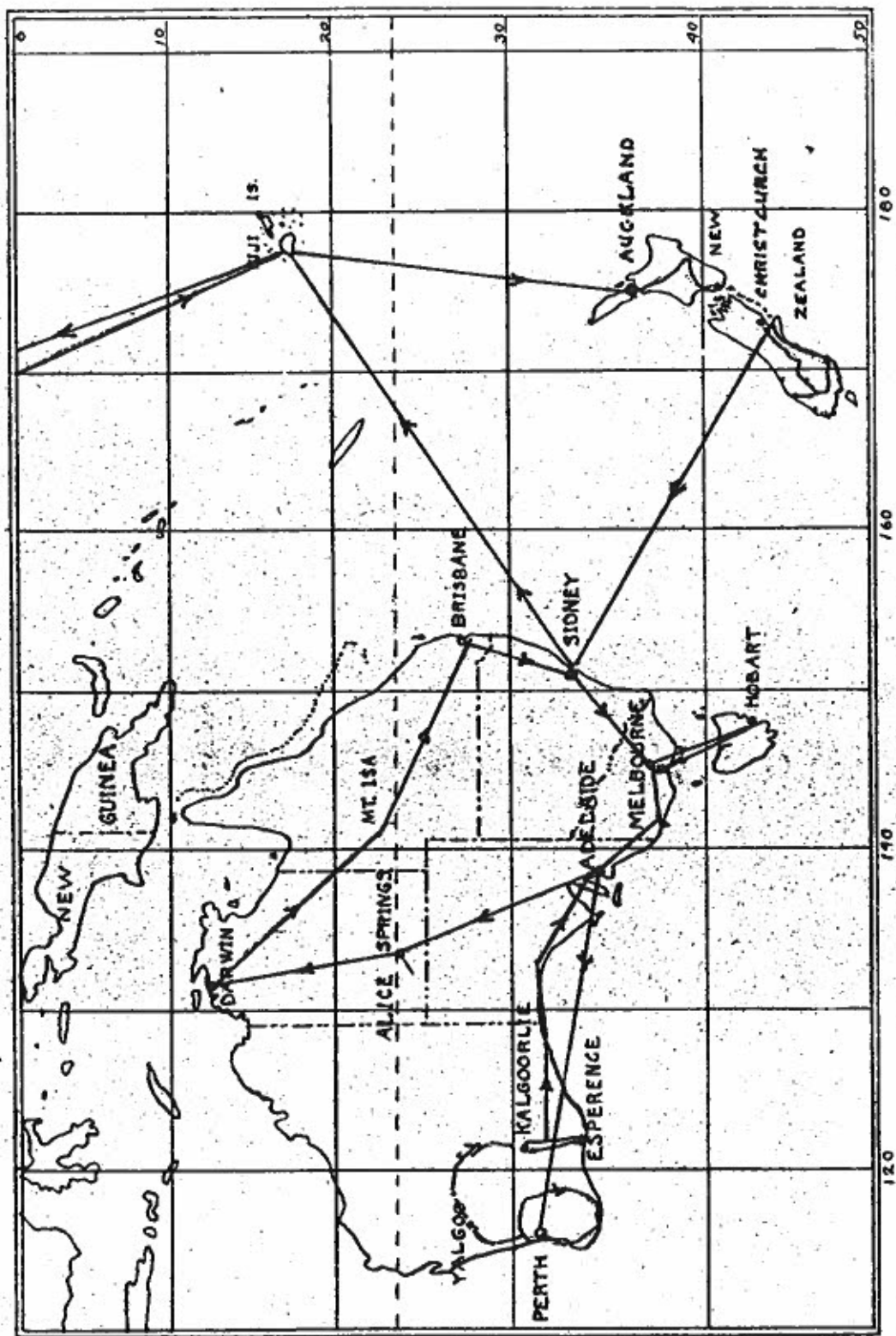
SHALLOW EARTHQUAKES x
 SHALLOW-HEAVY *
 INTERMEDIATE ▽
 DEEP ▲
 DEPTH - 100'S KM 1-2-3-4-5-6.

Fig

SCALE 1" = 360 MI

AFTER - GUTENBERG & RIHTER





Map of our trip (my wife Katherine and I) "Down Under and off To Oneside" in December of 1959 and January 1960. Mrs. Kelly flew home from Melbourne and I continued on to Perth where I met the Niningers as arranged, and we continued the trip together the rest of the way. AOK

