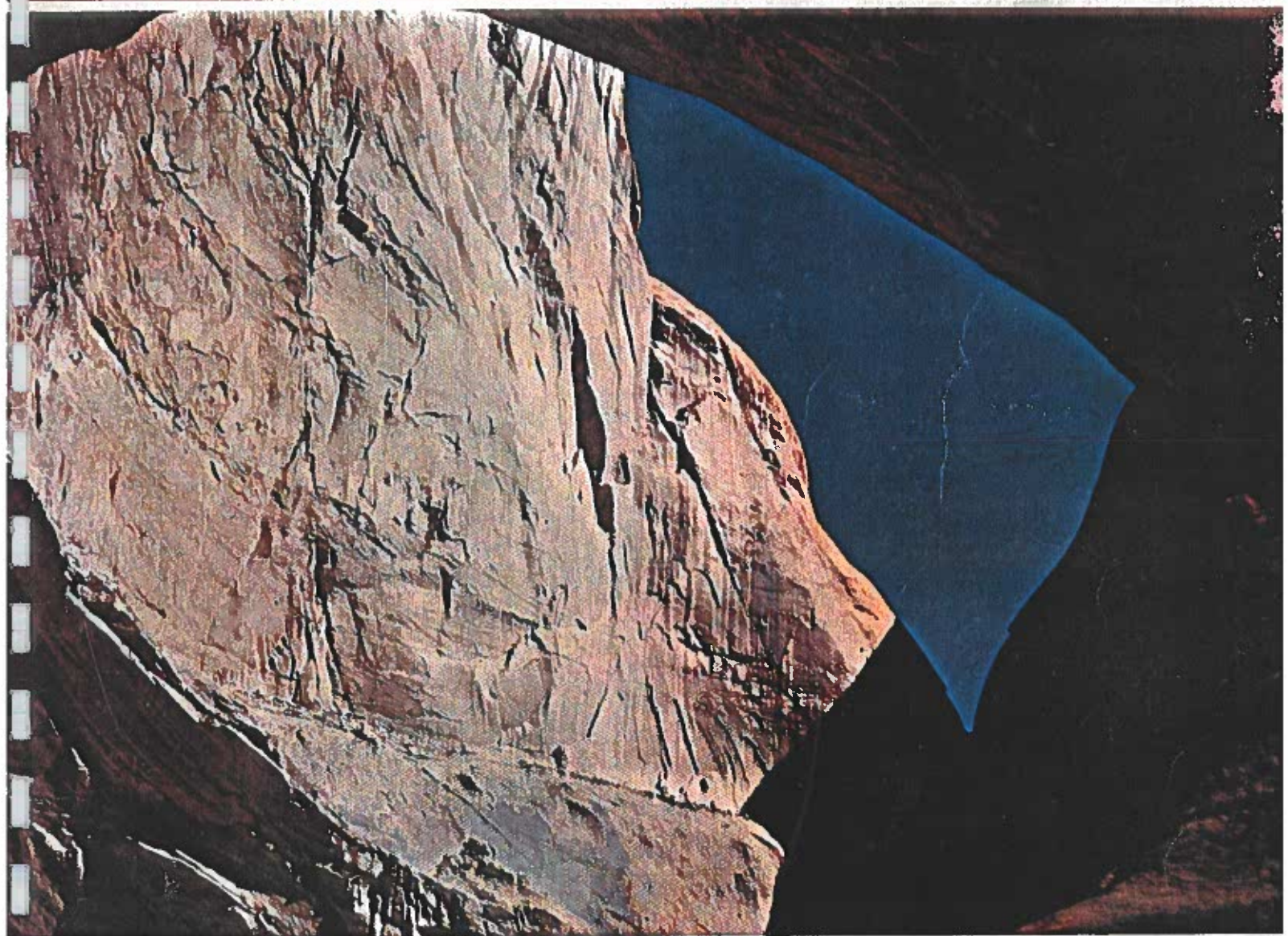
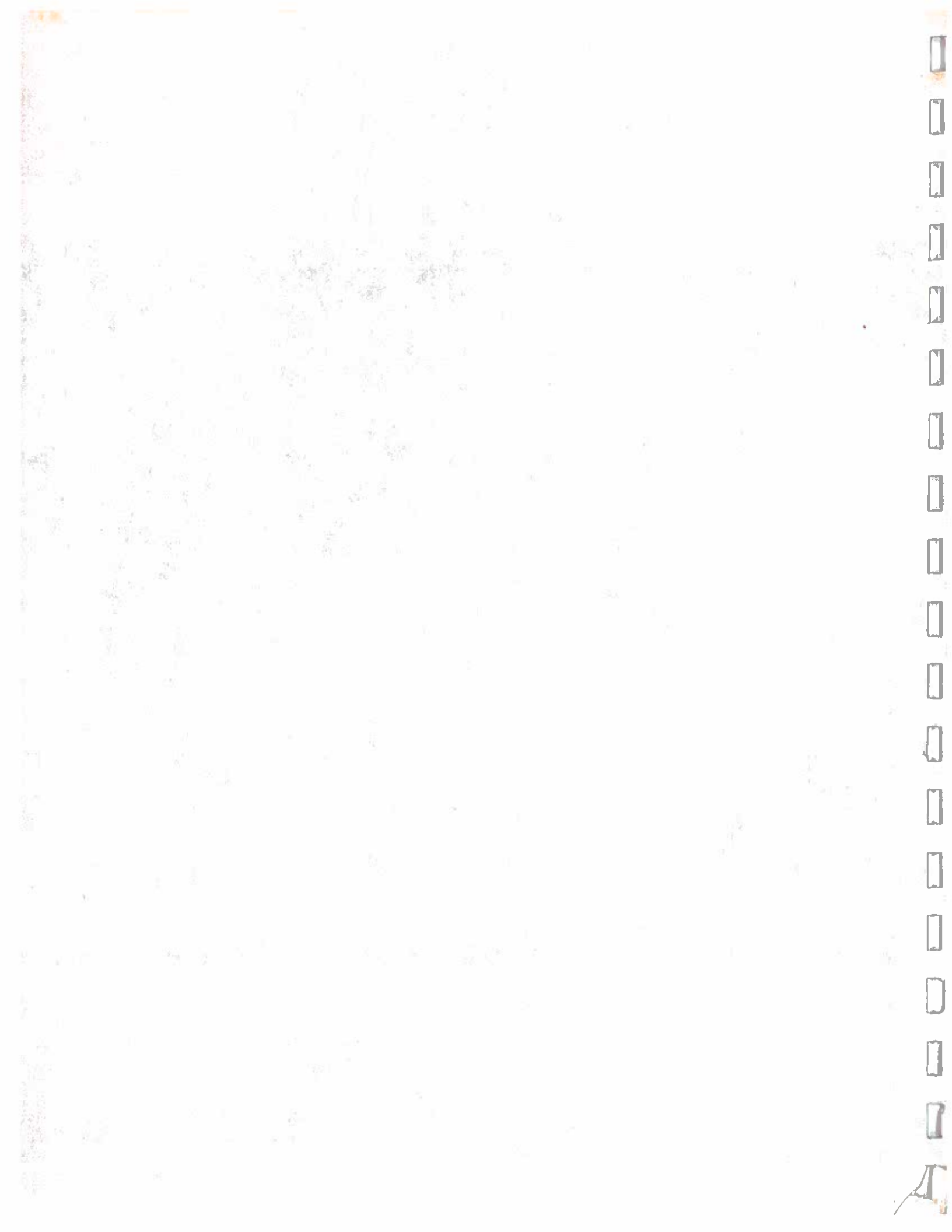


METEORITIC COLLISION



A Dynamic Force in Earth History

1963

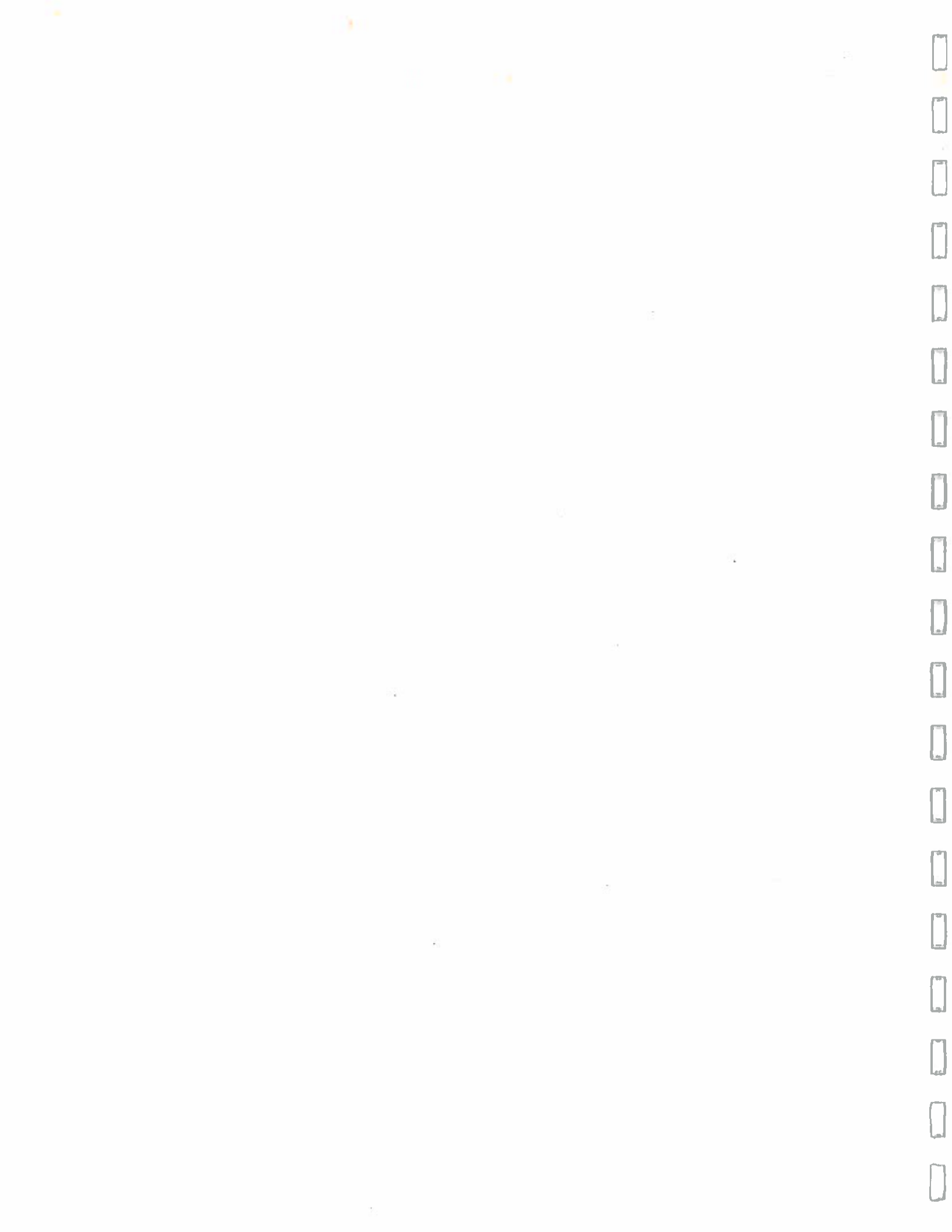


ERRATIC SEDIMENTS

By

ALLAN O. KELLY

March 1963



Every geologist is familiar with erratic boulders which are sometimes referred to as "traveled" boulders. They are among the most spectacular features of glaciation and every textbook that deals with this phase of geology mentions them. In fact, the recognition of "traveled" boulders in northern Europe was the trigger idea that led to the extensive study of glaciation and to the development of the theory of the "Ice Ages." Much has been made of the great distances these boulders have been transported and their tremendous size, some weighing more than 100 tons.¹ Through years of study and research, geologists have accumulated a wealth of knowledge in this field and established glaciology as one of the most important branches of geological science. There are some aspects of this subject, however, that have not been given too much consideration and one of these is the fact that not only large boulders, but stones of all sizes, down thru gravel, sands, and finer sediments may be just as erratic, just as "traveled", as if they weighed a hundred tons.

Erratic sediments are found all over the world; in every land and every climate; on the continental shelves, the deep ocean floor, and even in the abysmal depths of some of the oceanic trenches. In short, they are found in many places and under circumstances which make it impossible to believe that they were transported by ice or by the ordinary forces of stream, wind, mud flow or ocean currents.

The purpose of this paper is to call attention to some of these "traveled" sediments found in strange places; to point out some of the anomalies connected with them, and to make some suggestions as to their origin. First, it must be said, that all of these sediments from boulders down to loess, may be found as the product of the ordinary forces of transportation and deposition; we are concerned here, *only with the erratic and extraordinary conditions.*

SANDSTONE – Sandstone is the most abundant of all of the consolidated sedimentary rocks and quartz is its chief ingredient. When deposited under normal conditions, sand is always interbedded with finer and coarser materials and often occurs in pockets and lenses as well as in layers. When sandstone is found in beds hundreds of feet thick, very uniform in grain size and not interbedded with other sediments, it becomes evident that the process of accumulation must have been different from that going on today. For example, the Navajo Sandstone of the Colorado Plateau is over 2,000 feet thick in places, and spreads over hundreds of square miles. It forms the sheer cliffs of Zion Canyon, Monument Valley, the walls of Glen Canyon, Utah, and the arch of the famous Rainbow Bridge. (See photo 1.) The reason that it can stand in arches and sheer walls hundreds of feet high is that it is a very hard rock, so hard, in fact, that it fractures like flint in huge fan-shaped patterns. The fineness and uniformity in grain size in the Navajo Sandstone is quite remarkable. A fifteen power hand glass is required to resolve the individual grains and a microscope is needed to really see their shape and character. In respect to fossil content, Dunbar has said of this formation: "The Navajo Sandstone proper has yielded but few fossils, (fragments of two dinosaurs and rare dinosaur tracks) and its position in the Jurassic System is still uncertain."² Dunbar does not say who found these fossil remains or where they were located. Chamberlin & Salisbury locate these fossil dinosaur



1. Rainbow Natural Bridge looking north. About 1,500 feet of the Navajo Sandstone is exposed in this photograph and it illustrates how completely the massive domes and basins have been swept of gravel and how little vegetation has been able to take root. The little stream working here today is carving its little canyon down in the bottom of the tremendous canyon carved by oceanic flood.

tracks in "a limy member of the Navajo Formation in the Painted Desert, Arizona, and credit R. N. Field as discoverer."³ The Painted Desert is apparently considered a part of the Navajo Formation, but anyone who has visited there knows that it is made up of soft variegated clays of bright color and a few thin beds of sandstone and in no way does it resemble the sheer walls of the Navajo Sandstone. Indeed it is doubtful that any fossils have been found in the Navajo Sandstone proper.

A secondary feature of the Navajo Sandstone is its cross-bedding which is wide-spread but not found everywhere within the formation. Most travelers notice this remarkable feature at once and remark about it, for it is exposed in dozens of places along the main highways. Cross-sections hundreds of feet high are often seen in which one bed follows another without interruption save where the thin, flat planes separate one bed from the next. The thickness of individual beds may vary from a foot or less to as much as ten or fifteen feet, or pinch out altogether. The slope of individual strata varies considerably too, from as little as 15 degrees to as much as 40 degrees. Most geologists believe that the cross-bedding in the Navajo Sandstone is of aeolian origin, the sand dunes having been deposited under desert conditions.^{4 5} It is the writer's observation, however, that no land area or mountain system on earth today could produce so uniform a product in so vast a quantity, in any length of time.

Orthodox geologists insist that there is nothing unusual about such deposits as the Navajo Sandstone; given sufficient time, they say, the natural weathering process will crumble the rocks and remove all of the soluble minerals and transport them to the sea. Quartz, being the most durable, will remain, with only a little iron oxide or silica as the cementing agent.

At this point one might ask why the iron oxide and the silica were not transported to the sea? If the purity and uniformity of sandstone is only a matter of time and continuous refinement, then we should find tremendous beds of practically pure crystal sand hardened into quartzite. We do find tremendous beds of quartzite but nothing with any degree of purity or uniformity such as the Navajo Sandstone.

Of cross-bedding we might ask: If this is a product of wind, how is it that each succeeding bed is cut off from the one below by a smooth, flat plane, as if sliced with a knife? What kind of wind sliced off the crest of every dune and left only a thin, flat bed, seldom more than a half inch thick? Why is it that all of the thin strata in one bed slope in one direction, while the next bed above or below, may slope in the opposite direction, or at some angle thereto? Did the wind blow from one direction for hundreds of years to produce one of these beds ten feet thick, and then suddenly change and blow in the opposite direction?

Why does the bottom section of the Navajo Sandstone look exactly like the top section 2,000 feet above, if it is the product of millions of years of weathering?

And how are we to explain the sudden beginning of the Navajo Sandstone where it contacts the variegated shales and siltstones of the Chinle formation, or the complex and sudden change at the top where the San Rafael takes over? There are no old erosional surfaces or unconformities to mark a gap in time. The Navajo simply lies upon the Chinle and the San Rafael upon the Navajo.

In recent years a new kind of geology has been proposed called Cosmic Collision Geology. It holds that cosmic collision is an important factor in the dynamics of the Universe and that the earth, as a part of the solar system, has always been subject to this force, namely, the impact of large meteorites.*

The origin of the Navajo Sandstone then, may possibly be explained as a fallout product of a major meteorite collision in which hundreds of cubic miles of the earth's crust and the body of the meteorite (probably iron) were vaporized and blasted to hundreds of miles above the earth's surface. Such a collision would probably produce an incandescent cloud of gas and dust much like the mushroom cloud of an atomic bomb. When this cloud cooled sufficiently to condense, the silica might fall as a clean sand of uniform grain size, mixing but little with the other elements in the cloud that might have higher or lower boiling points. In this way,

*At a symposium on meteoritics at Arizona State University, Tempe, Arizona, March 10, 1961. Dr. Gerard Kuiper, professor of astronomy, gave the following estimate of asteroid numbers in relation to their diameters in miles.

DIAMETER IN MILES	NUMBER OF ASTEROIDS
50	25
30	120
20	600
12	3,000
8	16,000
5	80,000
3	300,000

the vaporized rock, iron, and other elements in the cloud, might have been spaced outwardly from the point of collision by the time required for the various elements to cool down to their condensation points. Thus billions of tons of fallout material such as the Navajo Sandstone might have come down in one area. If it fell in a large, deep lake or ocean basin, then the cross-bedding might have been produced by the collision-impelled water moving back and forth as the sand sank to the bottom. This is what must have happened because if it had come down on land, it would have been dispersed by wind and water transportation until the thick beds were gone. Of course this is an easy and relatively simple explanation of a cataclysmic event that must have been very complex. It is difficult, for example, to explain how the iron oxide got into parts of the Navajo Sandstone and not into other sections, where the cementing agent is silica. The boiling point of iron being so much lower than silica, it seems very unlikely that bits of quartz could collect a coating of iron oxide out of a hot, gaseous cloud.

INTERBEDDED SANDSTONES – This is a common occurrence in which more or less thin beds of sandstone are interlayered with marine clays or siltstones and less often, with carbonaceous or other mineral deposits. The individual beds of sandstone and shale are often quite thin, from a few inches to a few feet in thickness and not uncommonly, the thickest beds will be on the bottom of a formation with each succeeding bed above being a little thinner, until the whole blends into a sandy clay mixture at the top, perhaps due to a dying-out tidal action. The San Rafael group overlying the Navajo Sandstone is such a group of alternating beds, except that these beds are very thick, having a total thickness of more than 1,500 feet.⁶

The first anomaly to explain is the sudden break in formation from the Navajo to the San Rafael without apparent erosional hiatus. What caused the sudden change in type of formation? If the Navajo Sandstone is a wind-blown sand deposit as most geologists believe, then how did this unconsolidated sand get lowered 2,000 feet into the ocean (thru the surf line) and retain its beautiful cross-bedding until its top had sunk beneath the sea and the first layer of the San Rafael marine clay was ready for deposit? Following this miracle, how did this area manage to rise above sea level to accommodate the next layer of land sediment and then sink (a little extra each time) for the deposition of the following beds? Are we to believe that the earth's crust heaved up and down in this most remarkable and precise manner? If "the present is the key to the past," where does one observe this heaving up and down, or where do we find a sand dune sinking thru the surfline without complete annihilation? The added ingredient of extremely slow movement thru great lengths of time is no support for orthodox theory. The tiny waves along a small lake shore produce erosion that is visible to the human eye. This is relatively fast action.

LOESS – According to classical definition: "Loess is a buff-colored, wind-blown deposit of fine silt or marl, usually unstratified, which is often exposed in bluffs with steep to vertical faces. Loess is found in the United States in the Mississippi Valley from Louisiana to Iowa, and along

the course of the Missouri. The average thickness of the loess here is twenty feet, but may range from 50 to 100 feet. Loess also occurs in central Europe, Mongolia and China where it is said to attain a thickness of over 300 feet. The loess of the United States and Europe is believed to be the finer materials first transported by the waters of the melting ice sheets of the glacial period, and later blown to considerable distances and deposited in lakes. The Asiatic loess seems to be wholly wind transported, the source of the dust being, perhaps, the great deserts of central Asia. In the latter case the accumulation of such thick deposits is attributed to the binding power of successive generations of grasses whose former existence is suggested by the network of narrow tubes.⁷ This is the usual description of loess and its manner of origin, and as usual, the endeavor is, to make the physical facts fit the theory; to make the physical features derive from the dynamic forces now in operation. This cannot be done.

The loess deposits in the Mississippi Valley cover an area of more than 200,000 square miles, from the mouth of the Mississippi almost to Lake Superior, and into all of the tributaries on either side. It covers all of this territory like a blanket of snow, in and out of each tributary as if it had been deposited out of the mud-filled water of a gigantic lake filling the Mississippi Valley. If one can imagine such a mud-filled lake, then he can understand how the settling of this mud would cover each hill and slope and valley floor with a blanket of mud, the thickness of the mud varying with the depth of the lake. Obviously, 100 feet of muddy water will deposit a thicker layer of mud than ten feet of such water. It is significant, therefore, that in the Mississippi Valley the depth of the loess varies directly with its elevation above sea level. At Natchez, Miss., it reaches a depth of 70 feet but thins out to the east and west along the old river terraces that parallel the river on either side. Farther up the river, the thickness of the loess, to a great extent, follows contour lines in and out of the tributaries.⁸ This is the anomaly that is difficult to explain by ordinary wind and water transportation.

Those who claim that the Mississippi loess is a product of glacial outwash in which the fine rock flour was distributed over the river plains where it then dried and was wind-blown over the valley, must also explain why it increases in thickness with lower elevation and follows contours in and out of tributaries. Wind transportation should produce sand dune complexes which do not follow contours or spread as a blanket over hill and dale.

The meteorite collision explanation (hypothesis) would be that the loess was generated both by glacial outwash and collision dust. This very fine material was the last thing to settle out of the oceanic flood waters caused by the collision. This ocean water moved in and out of the Mississippi Valley many times, first, with great speed and cutting power, but finally as a vast but quite gentle tidal action.⁹ Each time the tide came in it failed to reach quite as far up the valley, and each time as it came to a stop and slowly returned, it dropped some of its fine mud. In this manner, the upper reaches of the Mississippi Valley were exposed to a lesser number of inundations and a lesser depth of water than the lower valley so that the blanket of mud (loess) deposited, gradually thinned out with increased elevation.

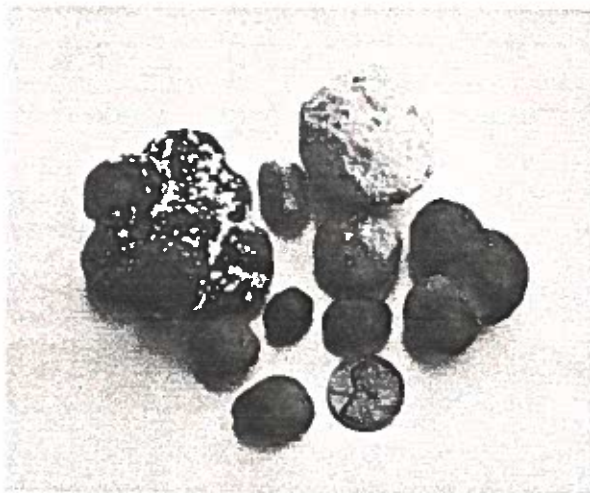
Since the time when this last cataclysm occurred (perhaps 11,000 to 12,000 years ago) wind and water erosion has altered this blanket of loess to a considerable degree but enough of it

still remains to tell the story; the story that loess is just as erratic as the "traveled" boulders found a little farther north.

LATERITE—Laterite is a term used to describe an aggregation of small pellets about the size of ordinary marbles. They are sometimes called concretions because of their onion-coat layering and their origin is given in geologic literature as follows: "The subaerial decay of rocks in tropical regions, having a distinctly moist or rainy climate, results in the development of a residual reddish, and usually sticky soil containing concretions. The principal products of laterization are the hydrated oxides of aluminum and iron either in the crystalline or amorphous form. If the concentration of iron is sufficiently high the laterite may be valuable as iron ore. If on the other hand, the concentration of alumina is high, the laterite may be valuable as ore of that metal."¹⁰

Nothing is said about transportation in the above description, whether laterite has been moved by water or other natural element, but there are some indications that it may be a "traveled" sediment.

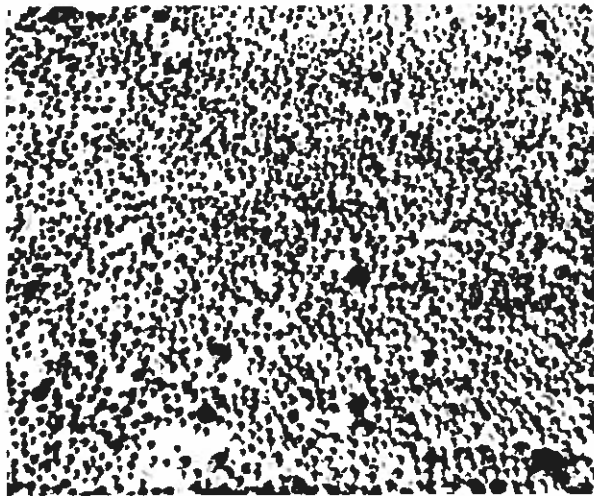
In Glen Canyon, Utah, one may see from the river boat, close-up views of laterite in the sheer walls of the Navajo Sandstone. These beds seldom exceed six inches in thickness and usually pinch out in a few dozens of feet. These little concretions are very hard and very firmly fixed in the sandstone and if they grew in a red, sticky soil in a tropical climate, there is nothing to prove it. The individual pellets average about one-half inch in diameter, but are sometimes found welded together in chains of three or four or in groups. (See photo 2.) In content they



2. **LATERITE.** The three pieces at the top are Limestone laterite from Australia. The lumps on either side are from Glen Canyon, Utah. The four separate pieces at the bottom are from San Diego County, Calif. The white specks on the lump at left are a kind of lichen.

are the same hard, fine-grained sandstone as the surrounding rock only a little darker in color, probably because of a higher content of iron, for this part of the Navajo Sandstone is cemented with iron oxide. On some of the benches and slopes along the Colorado River one may find patches of laterite completely weathered out of the mother rock and lying there, only one

layer deep. (See photo 3.) There is no indication that this laterite is a product of weathering in a moist tropical climate. This area is now a semi-desert and was a desert, according to orthodox geological theory, when the Navajo Sandstone was laid down. The same is true of climatic conditions in Southern California and in Australia where laterite is found.

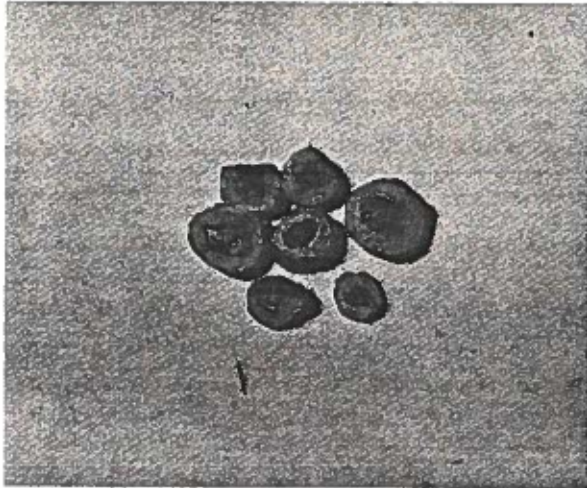


3. Laterite weathered out of Navajo Sandstone. Glen Canyon, Utah. This was only a small level area on top of a sandstone dome.

There are thousands of square miles of laterite in Western Australia, where it forms a blanket of loose marble-size stones from three to five feet in thickness, usually covering a red granite of coarse crystalline structure. Generally it is found as a loose agglomeration of pellets that may be dug quite easily with pick and shovel but in some areas it has hardened into a cap rock that is even more weather resistant than the granite. Around some of the big granite domes that dot this Western Australian landscape, the laterite is piled in deep drifts, sometimes 20 to 30 feet deep against the domes. Most gravel pits in Western Australia are in laterite for it makes an excellent road material. All that is needed is some heavy oil to make this "ironstone" into a very good "sealed road."

In northern Australia the "ironstone" is replaced by a laterite in which the cementing agent is aluminum oxide. It covers the whole country-side with a fiery red blanket several feet thick and this being a rainy, tropical jungle country (around Darwin) it answers to the classical description given above. The only marked difference between this and the "ironstone" is that the pellets are much smaller, only about one quarter inch in diameter.

Still another kind of laterite is found in the desert section of South Australia called the Nullarbor, (meaning without trees) where large patches of bare ground are covered with limestone laterite. This laterite averages much larger in size, many of the concretions being as much as an inch in diameter. When cracked open they often are found to contain angular chips of hard black rock that appears to be lava. (See photo 4.) These angular bits of rock, often a quarter inch across, have been covered with hundreds of layers of limestone that seem to have accumulated like the layers of ice on a hailstone. Usually this lime coating is thick enough



4. Limestone laterite from South Australia. These stones have been broken in half to show the angular bits of rock in their centers. The largest stone is 3/4 inch in diameter.

to have made the concretion almost round. Apparently some sort of rolling or tumbling motion was imparted to these bits of rock while they were being coated with lime. This implies visible motion, not something infinitely slow like weathering.

Very little attention has been given to the origin of laterite even in Australia, where it is a major feature of the landscape.

Jutson, in his "Geological Survey of Western Australia" gives the subject only one short paragraph out of a 350 page book; I quote as follows: "Laterite is extensively developed in Western Australia and may be ferruginous, siliceous, or aluminous, according to the predominant component. Its formation is essentially due to the decomposition of rocks by which iron, silica and aluminum are dissolved in circulating underground water. A portion 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."¹¹ This is really no explanation at all because it doesn't go far enough into the problem to consider the anomalies. Jutson is apparently unaware of the limestone laterite and its angular lava inclusions.

If angular bits of lava were to fall from the sky, due to some secondary explosive phase of meteorite collision, and sink thru deep water roiled up and filled with limy mud; then these bits of rock might accumulate layers of mud as they tumbled toward the ocean floor. The depth of the water and the time required in falling to the bottom, as well as the size of the rock chip, would regulate the size of the laterite. The uniformity in size of most laterite probably indicates that it fell in water of a nearly uniform depth and that the starter chips or grains of sand were of an even size. The center grains in "ironstone" and bauxite are usually no more than tiny grains of sand.

While this explanation may sound fantastic to geologist and layman alike, a little thought should convince one that small rock chips and grains of sand do not of themselves, revolve in sticky red mud or any other soil, until they have grown a hundred times their original size. Water cannot circulate in sticky mud, nor is it likely that groundwater could have produced the "ironstone" which is a loose agglomeration of pellets with only a little sandy soil mixed in

with the stones. There must have been some true motion applied in the formation of laterite and hence it becomes a transported erratic sediment.

ROCK SALT—Salt is not a true sediment in every sense of the word, especially that which is being formed today, but it has some erratic aspects that seem to give it a place in this discussion.

Ordinary salt is being made by the natural process of evaporation in many parts of the world, but nowhere on the gigantic scale or the high state of purity as found in the deep beds of rock salt that underlie many of the continents. The quantities of rock salt found in these beds is really unbelievable!

In the Permian basin of West Texas, more than a thousand feet of rock salt is interbedded with anhydrites, sands and clays, and some magnesian limestone. These beds continue with some thinning under eastern New Mexico, and much of western Kansas and Oklahoma.¹² They have been estimated to contain 30 billion tons of salt and to have required the evaporation of 22,000 cubic miles of sea water with a salinity like that of the modern oceans.¹³

Still other deposits of rock salt are found along the Gulf Coast in the form of salt domes. At least 73 of these domes have been located along the Gulf Coast from the Mississippi River to Duval County in South Texas. Many of them also contain sulphur and oil and have been drilled for the recovery of these minerals. Cores from some of these wells have revealed more than 5,000 feet of pure rock salt, so pure that it is often crystal clear like high-grade quartz. Salt domes have been found in Rumania, Egypt, Russia, Persia and North Africa.¹⁴ In shape, salt domes are usually quite round or rarely, oval and may vary in size from one to three or four miles in diameter. Their origin has been attributed to the fact that rock salt flows under pressure, and since it is lighter than the overlying rocks in which it may be interbedded, it can be forced up through weak spots to form columns or domes. One objection to this theory has been that rocks of the earth's crust tend to break along fault zones and this means that rock salt should have been extruded in long dykes rather than in columns or domes. There are of course, many areas such as Michigan and the Permian Basin mentioned above where thick beds of salt underlie thousands of square miles yet nowhere is there evidence of extrusion toward the surface. Apparently there must be some area where a great differential in pressure allows the salt to rise, for salt is not a liquid like lava that can melt its way thru narrow cracks or vents.

The circular nature of salt domes suggests that they may have had their origin in collision craters which occurred in nearly level sedimentary rocks already underlain with thick beds of rock salt. Such crater basins penetrating into the rock salt would allow for the extrusion of the salt into the basin and the rock debris thrown out by the explosion would add to the rock burden around the crater. As time went on and fresh sediments were deposited over the whole area, the crater basins already partially filled with salt, would receive a thinner and hence lighter load of sediments. Once this difference in static load was established, the salt column would continue to rise in the crater, no matter how many more layers of sediment were laid on top. If the supply

of salt was sufficient, the salt column would push up a dome and this would in turn erode away to add its weight to the surrounding surfaces.

However interesting this speculation as to the origin of salt domes, of even greater interest and mystery, is the origin of rock salt itself. How shall we explain the great bulk and purity of this common mineral?

Deep drilling in the Gulf of St. Lawrence has also disclosed tremendous deposits of rock salt. In talking with Dr. McNeil, a long-time geologist with the Shell Oil Company and now Professor of Geology at St. Francis Xavier University and mayor of the city of Antigonish, Nova Scotia, I learned that the Shell Oil Company drilled four wells in the Gulf of St. Lawrence basin; three of them on Prince Edward Island and the fourth near Inverness on Cape Breton Island. Of the first three, one stopped at 920 feet in granite; the second on the north end of the island went through several thousand feet of alternating beds of sedimentary and lava rocks; the third, drilled on a small island in the bay near Charlottetown, went to 17,800 feet. The first 9,000 feet of this well was in sedimentary rocks and then it went into rock salt and continued until abandoned, still in rock salt at 17,800 feet. This is quite a bit of salt but there may be more, for a recent gravimetric traverse of this area indicated a depth of over 22,000 feet. If this basin 200 miles across and 22,000 feet deep is ever proven to be a collision crater, then the energies released must have been sufficient to have caused some of the phenomena discussed here. Eight thousand eight hundred feet of rock salt is something of a phenomenon! It cannot be explained away as merely the ordinary slow process of sea water evaporation in a shallow basin over hundreds of millions of years. This would require an uninterrupted slow accumulation of salt just equaling the slow sinking of the basin, through whole eons and epochs of time; times in which great "revolutions" in the earth's crust were taking place nearby.

The Shell Oil Company drilled a fourth well, according to Dr. McNeil, on the west coast of Cape Breton Island below Inverness. In this well they struck rock salt at 910 feet and continued in it to 5,000 feet where the well was abandoned.

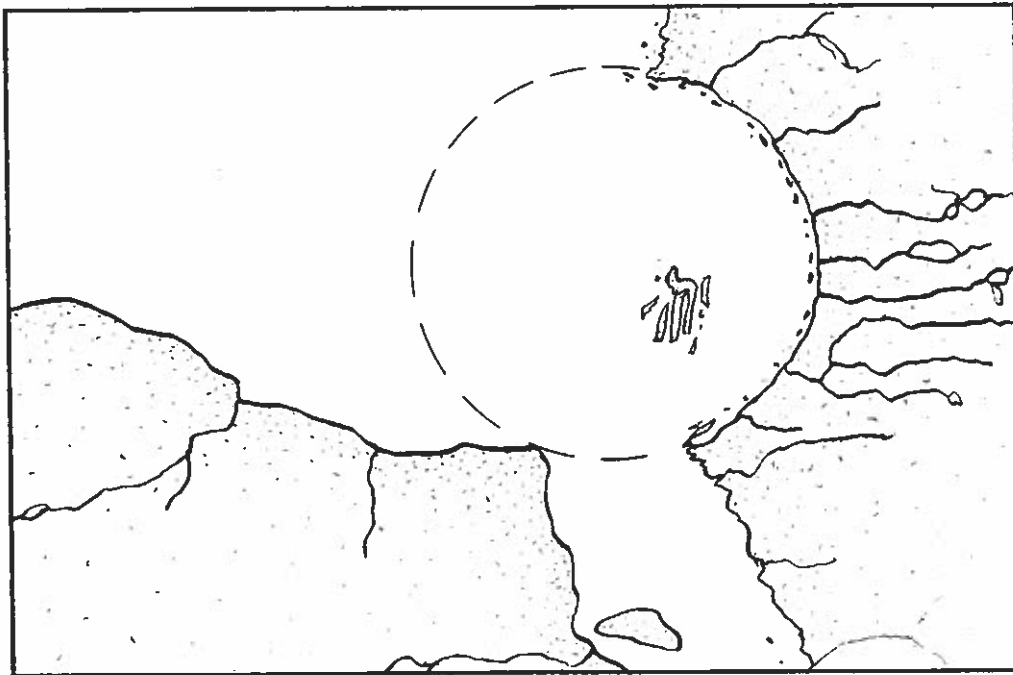
This western coast of Cape Breton Island is very rugged with highly contorted and altered micaceous rocks. Toward the north tip of the island the sea-cliffs rise from a thousand to twelve hundred feet, the whole formation dipping steeply under the basin to the west while on the other side of the island, the granite is highly faulted with the main beds dipping steeply to the east.

When considered as a whole, the Gulf of St. Lawrence basin has many of the same physical features as Mare Crisium, a crater-sea on the moon of 180 mile diameter.* Prince Edward Island forms a secondary rim that is duplicated on Mare Crisium as a crescent shaped rim of mountains. The Hudson Bay arc also has a rim of islands that closely parallel the shore. Another similarity is the central group of islands, the Belcher Islands in the Hudson Bay arc and the Magdalen Islands in the middle of the Gulf of St. Lawrence. In connection with the rim of islands, I learned an interesting bit of information from a retired sea captain who runs

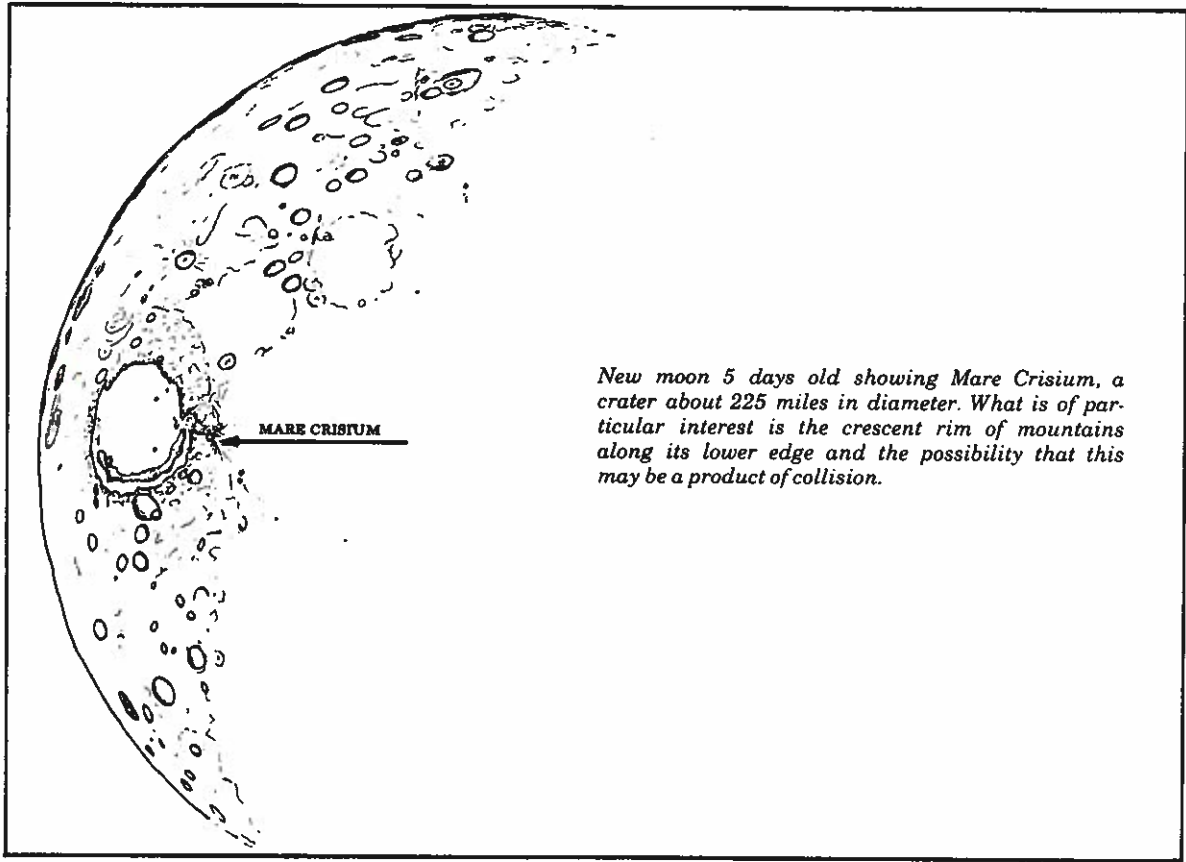
*Canadian scientists recently completed gravimetric surveys in the Gulf of St. Lawrence on the theory that it might be of meteoritic origin.



Gulf of St. Lawrence Arc. There is a possibility that a crater basin of this size would fill with molten lava and that chunks of the earth's crust along the crater rim might break away and float out on the magma, just as continents are thought to have drifted. Prince Edward Island may be of this origin and its contours may fit into the adjacent shore line. The Magdalen Islands near the center of the circle may be of this origin too or possibly a central peak formation of lava.



The Hudson Bay Arc. This arcuate structure has several features indicating that it may be a meteorite collision crater and no features that seem to deny the possibility. The Nastapoka Islands follow the edge of the arc closely and the strata in them is said to dip toward the center of the arc. The Belcher Islands, somewhat off-center are not volcanic but seem to match up with the rocks along the coast as if long chunks of shoreline had broken off the rim of the crater and drifted toward a common center just as chunks of wood will drift toward the center of a pot of boiling tar. Tar, heated in a pot, rises along the sides, cools a bit and flows to the center where it descends to be heated again. Any floating objects collect in a group in the center. The fact that the islands are off-center may mean that the meteorite came in at an angle from the Northwest and that the Belcher Islands lie over the deepest part of the crater.



a motel at Chiticamp, a resort and fishing village on this coast. He said that about ten miles off-shore there was a shoal area or "bank" that paralleled the coast for nearly a hundred miles, providing excellent fishing grounds. This may be an underwater extension of Prince Edward Island and it would be interesting to know if there is a similar underwater rim on the other side of the basin. It is quite possible that the Gulf of St. Lawrence is an ancient collision crater and that the tremendous deposits of rock salt found in this basin are, *somehow*, the product of collision. The high degree of purity of rock salt argues for a molten origin. The circular form of the Gulf of Mexico and its paralleling salt domes may support the theory too. If this seems like sheer speculation to the reader, rather than theory, then I must answer with a question: How does this physical evidence prove uniformity?

CONGLOMERATE, PEA GRAVEL AND BOULDER GRAVEL. First it should be said that all forms of gravel may be found in the geologic column as consolidated rocks and when so found, they are known collectively as conglomerate. When unconsolidated they are known as gravel.

T. C. Chamberlin coined the word "basal" conglomerate to indicate the fact that a coarse conglomerate often forms the base deposit on an old peneplane or erosional surface and he

pointed out that such surfaces and conglomerate deposits often mark the beginning of a new era in the earth's history. Collision geology sees in these planed-off surfaces and boulder gravel deposits, the record of a major collision in which oceanic flood first planed off the unconsolidated material and then deposited boulder gravel, followed by finer material. Good examples of peneplane surfaces followed by basal conglomerate may be found in the lower formations of the Grand Canyon. The word basal has been abandoned to a great extent, however, because clean erosional surfaces may also be followed by fine sediments. This does not disprove oceanic flooding but only that there wasn't sufficient coarse gravel to cover all of the cleanly eroded surfaces.

Of greater interest perhaps, are the tremendous beds of unconsolidated Pleistocene gravels that are found on all of the continents, and the anomalous conditions often associated with these deposits. As pointed out earlier, the erratic boulders that can be accounted for by ice transporation are discussed in almost every geology textbook, but those that cannot be so explained, are ignored. One geology professor told me that this was because they are unimportant. But I have found that many formally trained geologists do not know of the existence of erratic boulders in warm climates, simply because this information is not in the books. Out of curiosity, I searched the indexes of 26 geology textbooks and reference books for the words conglomerate, gravel and boulder gravel. Only 12 of them listed the first two words and none of them indexed boulder gravel. Most of the 12 explained conglomerate as a consolidated gravel that had been formed along the shoreline or the banks of a swift-flowing stream where strong currents could carry away the fine material, leaving only the coarse gravel.¹⁵ This is quite correct but it doesn't explain the anomalies. Not a word is said about the vast numbers of "traveled" boulders and lesser kinds of erratic sediments that inhabit all of the continents in the middle latitudes and in the tropics, and in places beyond any possibility of ice transportation. These erratics are too numerous to be overlooked.

Death Valley, California, presents some very interesting and erratic sediments. First, the gravel fans are often out of harmony with the canyons and drainage areas above them. A big canyon may have a small fan and a small canyon too large a fan or, a fan may be found leaning against a mountain wall where there is no canyon or against the end of a ridge. Second, many of the fans in Death Valley are too steep to be of natural stream origin, as are most of the old Pleistocene fans over the Great Basin. Proof of this assertion lies in the fact that these over-steep fans are all cut with narrow, deep trenches, where modern day erosion is cutting into the loose gravel and carrying it down to the valley floor to be redeposited in normal fashion. (See photos 5 and 13.) At the north end of Death Valley near Furnace Creek Ranch, there is a large fan at the mouth of Furnace Creek. This fan is normal in every respect because Furnace Creek has a very large watershed and the flash-floods of the last few thousand years have covered up or completely removed all sign of Pleistocene gravels that may have been there. On either side of Furnace Creek the old Pleistocene fans have been cut to ribbons but the tops of the ridges still show the original surface of the fans. (See photo 5.) This over-steepness of fans cannot be explained as the result of down-warping of the valley floor although the eastern side of Death



5. Death Valley, looking south from Furnace Creek Ranch. Note wide expanse of Furnace Creek fan and the highly eroded Pleistocene fan in lower left corner of photo. Looking far down the valley, big fans may be seen on the right (western side) and none at all on the eastern side.

Valley does show strong fault scarps in many places for, as pointed out above, over-steep fans are common all over the Great Basin. It is very unlikely that all of the mountains in this area have been pushed up (valleys thrown down) since these sediments were deposited. The area is too great and the time too short.

A third anomaly about the alluvial fans of Death Valley and the Great Basin is that in some areas they resemble the riverbend deposits that we see on a much smaller scale in ordinary river valleys. Death Valley has this characteristic as does the valley to the south which is really only a wider continuation of Death Valley. The whole depression is some 160 miles long and ends in Soda Lake south of Baker, California. (See photo 7.) A series of gigantic fans or aprons alternate from one side of the valley to the other forming a long winding valley that has no river bed but only a series of dry lake beds along its length. An even clearer example of this kind of erratic sediments is seen in winding aprons that line the long valley that extends from Tonopah, Nevada, to Battle Mountain, Nevada. This valley is 190 miles in length and has continuous mountain ranges on either side that rise from 3,000 to 5,000 feet above the valley floor and there are individual peaks that rise to more than 9,000 feet above sea level. This is a desert region of low precipitation, most of which comes in the form of snow. Summer thunder storms of cloudburst proportions are very rare in this part of central Nevada as proven by the lack of boulder gravel debris. The fans or aprons are beautifully smooth and winding as

if made by deep water flowing thru this valley. Most of these fans are perfect in form without a sign of stream coming out of the canyons in which they head, but a few of the 9,000 foot peaks produce enough run-off to form small creek beds (lined with trees) that disappear before they reach the valley floor. The valley floor proper is completely devoid of stream or river bed; only an occasional dry lake proves that on years of extra heavy snowfall, sufficient groundwater percolates thru the gravel to form lakes. Elsewhere, only a covering of grey, desert sage sweeps down across the valley and up the other side, leaving not the faintest sign of dry stream bed anywhere. Without stream bed or other sign of erosion, how are we to use the present as the key to the past? These are erratic sediments because they have no orthodox explanation.

A fourth type of erratic gravel deposit in the Great Basin is the gigantic alluvial swell; the mountain of gravel with a few tiny peaks projecting thru its summit. This may be found in all stages of development and at many different elevations, but most often along the lower Colorado River valley. This type of landscape is described in geologic literature as: "The final stage in the sculptural evolution of a mountain range." It is usually illustrated by cut-away block drawings of a mountain range in its three stages: youth, middle age, and old age.^{16 17} The first block shows a high, rugged young range with small fans at its base. The second block shows well worn mountains with larger fans. The third block shows only a long swell with a few tiny peaks protruding through the surface. To clinch the argument, photographs of the three stages in the evolution of a mountain range are shown.

All this seems logical to the student who has not had the opportunity to travel thru these desert mountains with a sharp eye and a questioning mind, for one must see this whole desert region, not just a photograph of one mountain. The modern authorities and publishers of textbooks should reconsider their scientific approach, spend a little less time in the library. What the observing geologist should be looking for in his field trips is the anomaly. The young mountain next door to the old mountain, or the mountain nearby that is young on one side and old on the other, judging by the size of the fans. Or the long valleys described above whose paralleling mountains alternate between young and old, if we are to judge by the height of the fans and the protruding peaks. The facts are that all sorts of mountains in the various stages of supposed "sculptural evolution" may be found in relatively small areas of the Great Basin, and a little serious thought should convince any serious student of geology that no amount of block faulting and tilting could have produced all of the anomalies seen in this region. These gravel deposits are very recent in origin and do not represent truly old land surfaces. Old land surfaces tend to produce small rounded hills without large fans if located in desert regions. Sharp peaks protruding thru huge gravel deposits are unnatural because as a mountain peak diminishes in size its watershed cannot carry away the debris and *weathering in place* takes over. This produces rounded hills instead of small sharp peaks.*

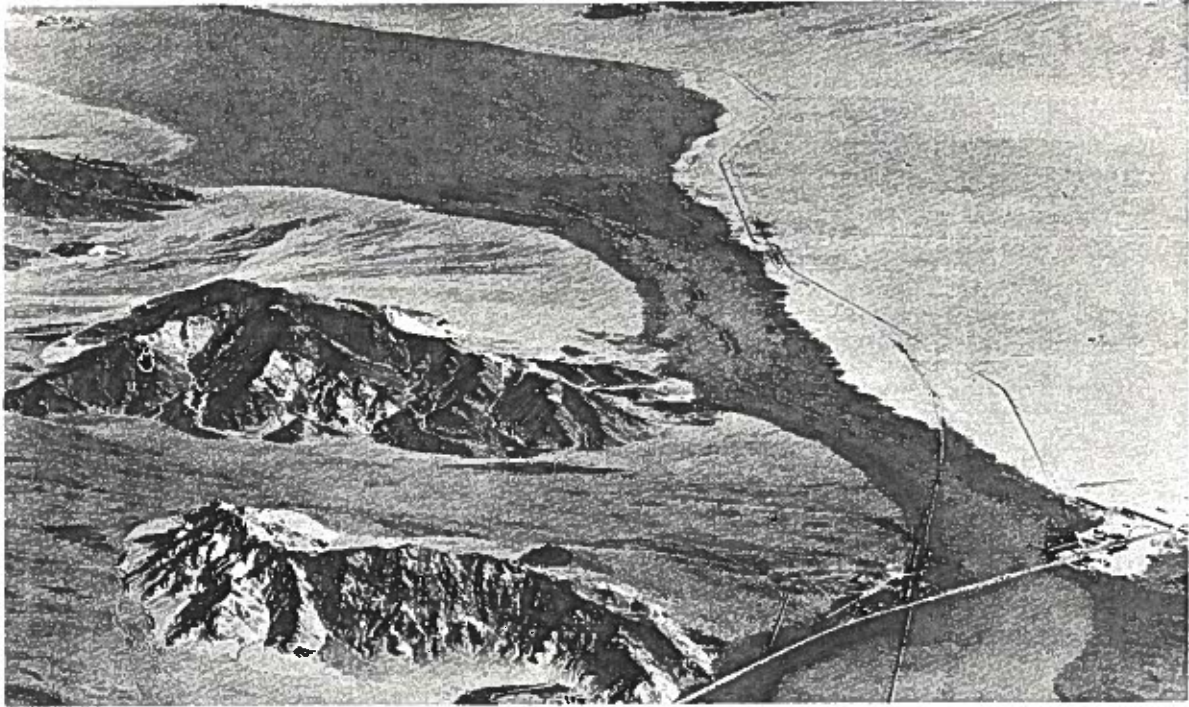
*The ancient land surfaces of the Western Andes in Peru, at elevations between 14,000 and 15,000 feet show granite mountains reduced to low rounded hills and plains without fans. There is no evidence that oceanic flood ever reached this high desert region, but evidence of extra-ordinary rainfall and snowfall is evident around Lake Titicaca in the form of Pleistocene river terraces along the big valleys entering the basin. Glaciers on the higher peaks appear to have moved down about 1,500 feet for a very short time, leaving only minor lateral moraines and no terminal moraines.



6. Part of the Toiyabe Range that forms the west side of the long winding valley that leads north from Tonopah, Nevada to Austin, Nevada. The mountains are steep, the fans are smooth, without stream beds and the valley floor is also without stream or riverbed.

The only logical explanation of these strange and erratic sediments among the rugged ranges of the Mojave Desert, is that oceanic flood waters surged thru these mountains, interacting and rebounding in a way that caused the uneven and unusual deposition of gravels. (See photos 6, 7, and 8.)

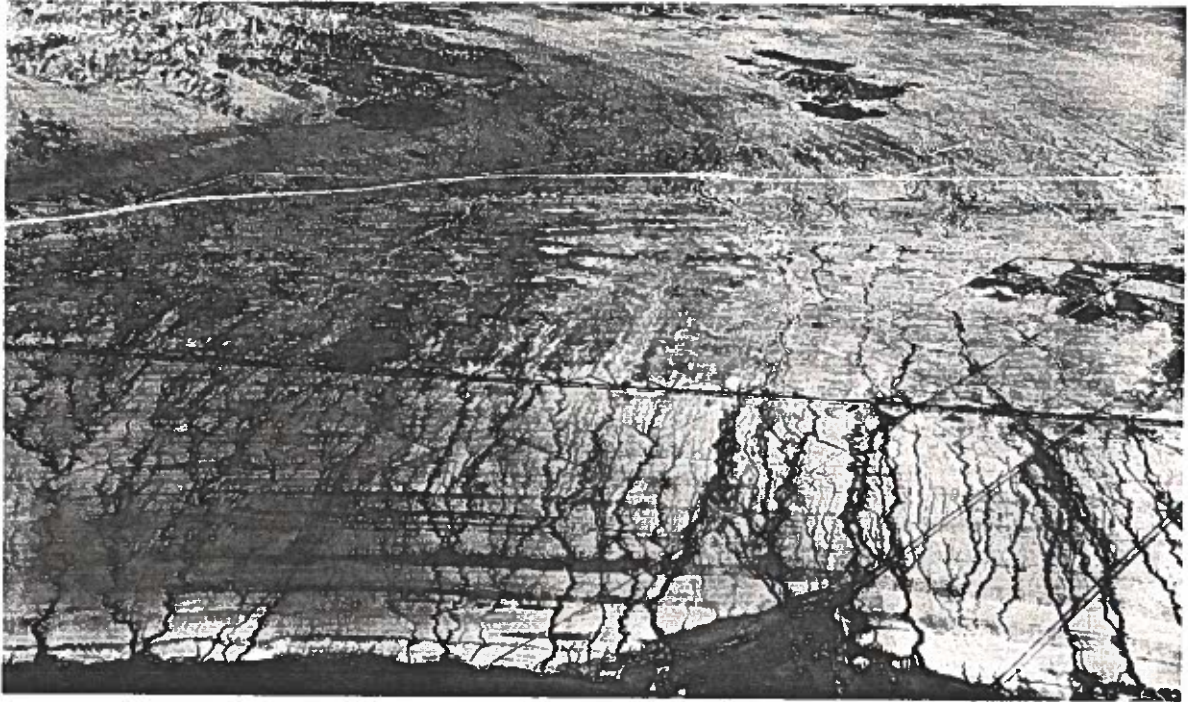
A fifth kind of erratic sediment is that found in Death Valley where sediments have been deposited in up-side-down order. Instead of the heavy boulders and coarse gravel being deposited at the peak of the fans and the finer gravels and sands being carried down to the valley floor, the reverse is true. Thick beds of a blue pea gravel are found in the heads of these over-steep fans where recent cloudbursts have cut deep trenches. This recent erosion not only reveals the depth and uniformity of the fine gravel but also shows that modern cloudbursts are behaving in a normal way, dropping the big boulders at the mouth of the canyon and carrying the finer material on down the slope in order of its size and weight. This condition may be seen to good advantage in Mosaic Canyon just above Stove Pipe Wells, Death Valley. (See photo 11.) Apparently when the ocean water moved thru Death Valley it slammed into one wall and then the other, carrying the light sands and gravels high into the canyons, but the heavier stones were dropped farther down the slopes of the fans and in the deeper parts of the valley where the water was deep and the current swift. Another characteristic of these fans which supports



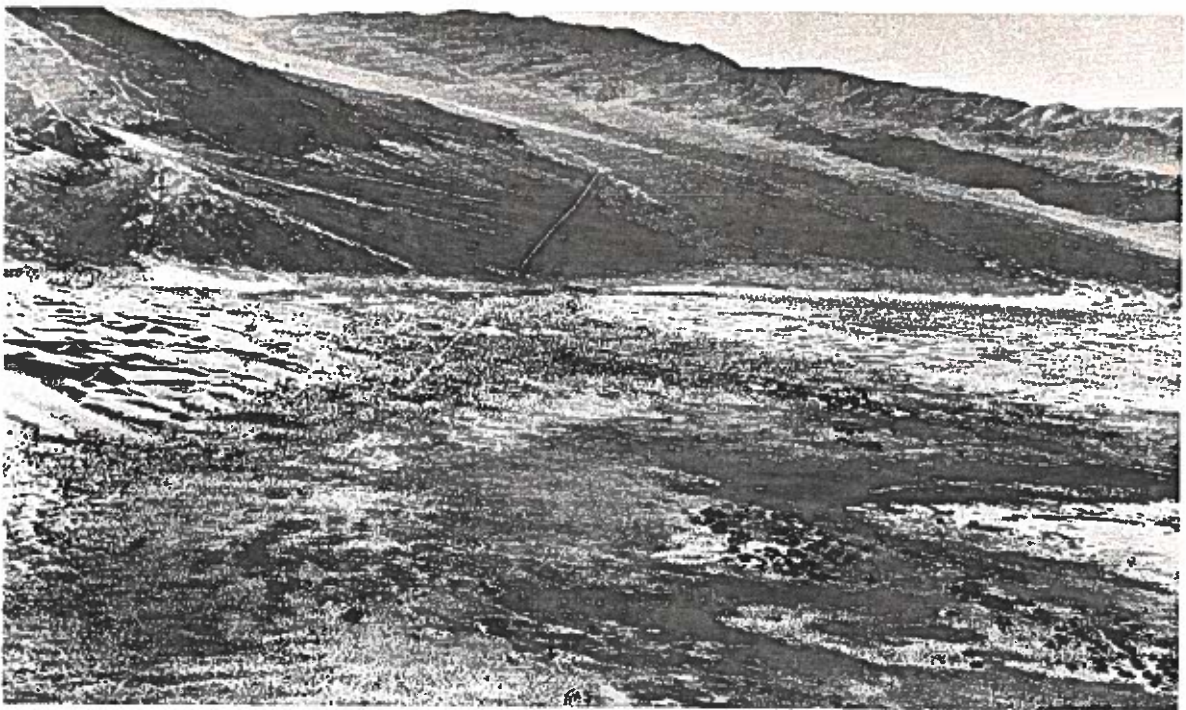
7. Baker, California, looking north toward Death Valley. The toe of the big fan coming down from Halleron Springs is seen on the right. Note how all the fans in this photograph join and blend as one huge deposit rather than as many separate fans from many different cloudbursts, that we know produce the only kind of erosion and sedimentation going on here today.



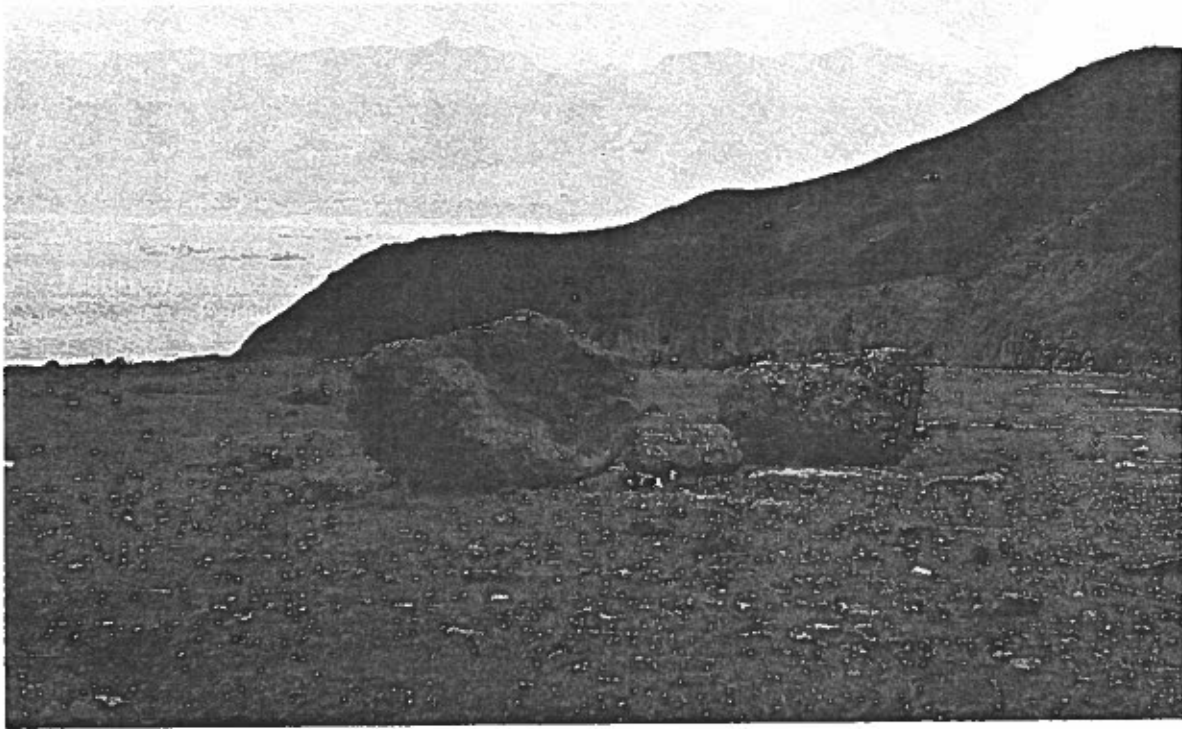
8. Alluvial deposits along the Gulf Coast of Lower California, Mexico. Note uniformity of slope of all the fans which seem to blend into one great deposit arising out of one great flood action.



9. The northeastern end of Imperial Valley, California. 11/11/41. The edge of Salton Sea shows at the bottom and many shorelines of the lake that once occupied this basin. The uniformity of erosion and the deposition of the gravel as if accomplished by one great flood, is evident in the background beyond the road. Southern Pacific Railroad in foreground.



10. Death Valley, California. Looking west up Immigrant Pass. Stove Pipe Wells is seen on highway at foot of fan. Mosaic Canyon comes out of the mountain, upper left. These fans are over-steep and are being cut down and re-deposited in natural order.



11. Cloudburst boulders lying on blue gravel near mouth of Mosaic Canyon, Death Valley, California. Original surface of the fan is seen over the top of the boulders where blue gravel cliff lies against the mountain side.



12. Looking east toward Funeral Range, Death Valley, California, from a point just east of Stove Pipe Wells. Note how fan peaks in little canyon instead of big canyons on either side, also coarse gravel in foreground on level valley floor.



13. Telephoto shot of distant fan seen in No. 12 showing detail of deep cut in head of fan. Note talus slope where gravel has fallen from cliff in head of fan and how angle of repose matches slope of fan peak.

the theory of oceanic flooding is that some of the small fans in the south end of the valley are very steep, as much as 30 degrees and located against exceedingly steep mountain walls. One might almost suspect them of being talus slopes except that they are made of the fine blue gravel that seems to be the chief ingredient of most of these fans. Apparently these gravel fans have been thrown up against the mountain walls rather than having come down off the walls.¹³ Toward the north end of the valley and high up on the east side, other remnants of blue gravel are seen hanging on the tops of ridges and little plateaus where erosion has failed to carry it away. It is easy to see from the valley floor because of the color contrast with the brown "desert varnish" of the surrounding rocks. (See photo 14.)

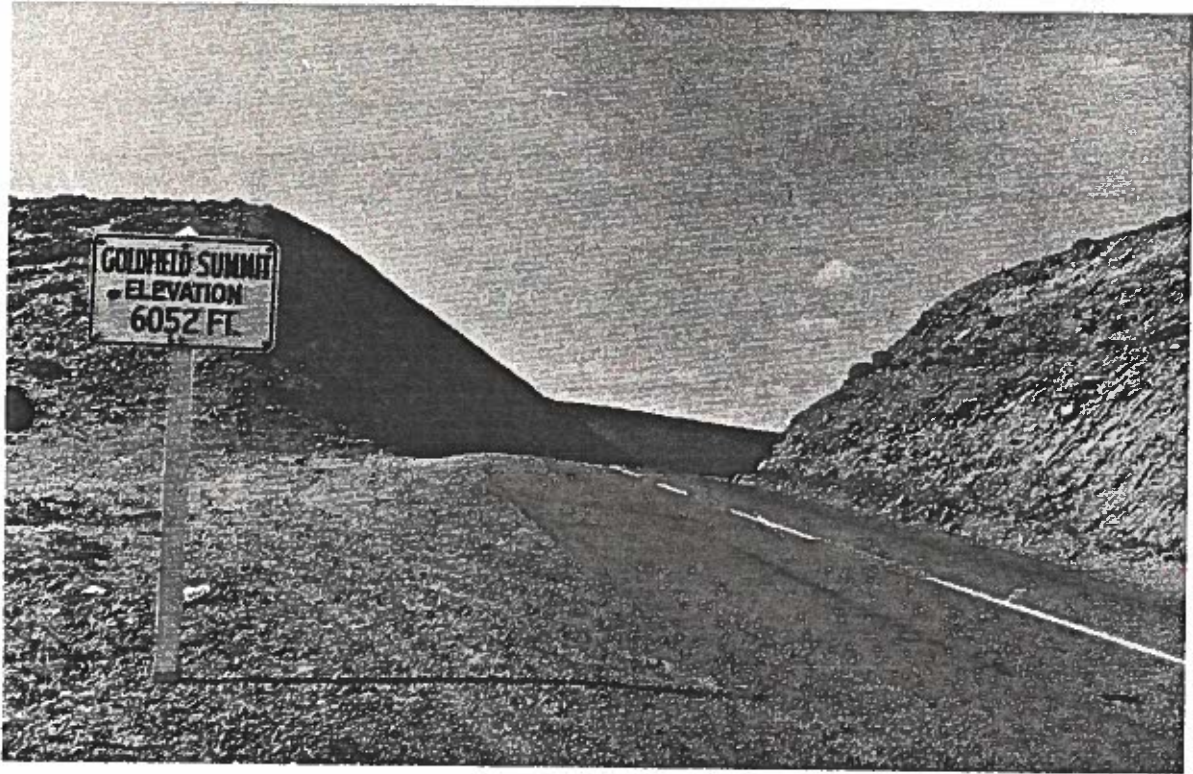


14. Telephoto shot of blue gravel lying high on the side of Grapevine Mountains. Death Valley, California. Note smooth surface of gravel deposits and light coloration.

Still another kind of erratic gravel indicating oceanic flooding is the presence of huge gravel deposits in the tops of many of the mountain passes in western United States. Most of these deposits have been described in a book called *Target:Earth*.¹⁸ (See photo 15.)

Fantastic as all this may sound, it seems to be the only reasonable explanation. What is needed is a great deal more study and detailed field work. To those who will not believe the picture I have drawn, I can only say: All these erratic sediments are still in place for anyone to see. To quote Bertrand Russell: "What is needed is not the will to believe, but the wish to find out, which is the exact opposite."

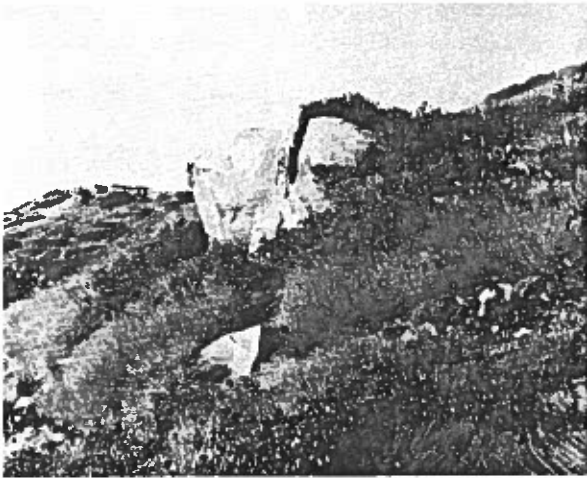
Near the end of Point Loma, California, (most southwesterly point in the United States)



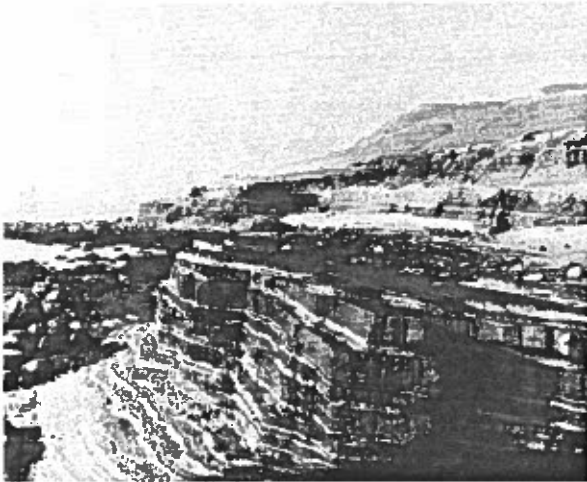
15. Goldfield Summit is a good example of what may be found in many other mountain passes in western United States. There is no apparent source for this gravel. It lies at the headwaters of two streams one running north and the other south.

there are hundreds of erratic boulders of many different kinds scattered over the western slope and down along the shore. One of these, a basaltic boulder weighing close to 50 tons, is lying on hard sandstone at an elevation of about 350 feet above sea level and only a few hundred feet from the Old Spanish Lighthouse. (See photo 16.) A few other large boulders may be seen sticking above the low brush that clothes the Point and down along the sandstone beach, hundreds more are exposed at low tide. The sea-cliffs proper, are made of a thin-layered siltstone that stands in bluffs some twenty to thirty feet high, the whole being indented with many shallow caves and a few separating stacks. These beds dip to the east under Point Loma at an angle of about three degrees, forming a shelf upon which many more erratics are found, having eroded out of the soils and gravels that lie along the foot of the Point. (See photo 17.) The nearest source of the big basaltic boulder is probably the north Coronado Island which lies about twenty miles south and a little west of Point Loma. Of the other varieties of rock represented along this beach, most are lavas or metamorphic rocks from Lower California. There are also a few granites and sandstone concretions, but not many. The sandstone concretions could have eroded out of the sandstone in Point Loma and the nearest source of granite is in the mountains to the east of San Diego.

These erratic boulders have never been described in scientific literature, so far as I have been able to learn. There are many more deposits of erratic boulders in Southern California, some of which have been described in Target:Earth.¹⁹



16. Large "erratic" boulder near the top of the ridge Point Loma, California. Recent weathering has split this boulder in half but the two parts are estimated to weigh about fifty tons; smaller boulder may be part of larger one.

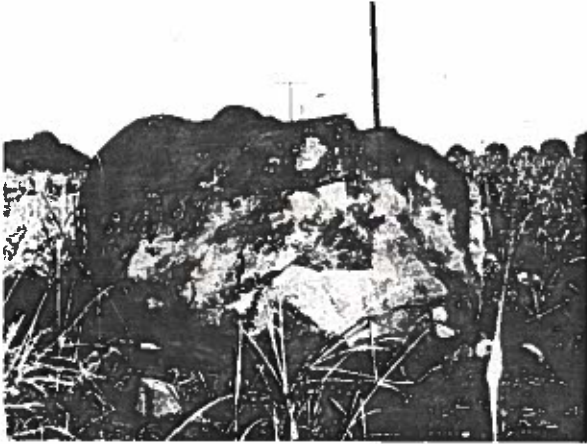


17. Siltstone sea cliffs on western side of Point Loma, California. Photo taken at low tide when large erratics were exposed on the beach. Others may be seen on top of sea cliffs. There are many different kinds of rock represented in this collection of boulders.

In the Gulf of California, some thirty miles north of the city of La Paz, Lower California, there are two small islands of solid rock that have been joined together by a bed of boulder gravel that appears to be at least 150 feet in thickness. It is well stratified in flat layers and contains many large boulders that can be seen from quite a distance. This boulder gravel bar is flat on top and almost as high as the islands it joins together, and on the south side of the smaller island, the boulder gravel continues in a long tongue that slants into the sea; a most beautiful job of natural streamlining.

Farther south on the eastern shore of the Peninsula of Lower California, there is another deposit of boulder gravel that seems to line up with that on the island. This is at a place called Los Barrilles. At this point the water in the Gulf is quite deep right against the shore and, curiously enough, the boulder gravel starts right at the shore as a flat topped delta about 150 feet high and continues inland a little distance to a low range of hills. It makes no sense as a river deposit in this particular place, but has all the appearances of having come out of the Gulf, and of having been carried inland against the low hills. These transported boulders cannot be attributed to ice and certainly not to stream erosion.

18. Erratic boulder in sugarcane field about 20 miles east of Cordoba, State of Veracruz, Mexico.



In the state of Veracruz, Mexico, there is an alluvial fan that may be the largest in the world. It heads in the canyons on the eastern flank of Mt. Orizaba (Coscomontepec) and slopes all the way to the Gulf Coast at Veracruz, a distance of more than 80 miles. The rivers that rise in the snows of Mexico's highest volcano, (18,696 feet) have cut deep canyons thru the head of this old alluvial fan so that one may see cross-sections of its contents, in some places more than 200 feet in thickness. Revealed in these canyon walls is a solid mass of boulder gravel, so solid indeed, that farmers cannot plow the flat land on top of this fan because of the boulders but must resort to crops like sugarcane, coffee, bananas and mangos, plants that must be set out by hand. The head of this old fan is between six and seven thousand feet (I can only estimate the elevation from towns nearby) and swoops toward the Gulf in a long curve that is steepest toward the top and gradually flattens out as one descends the slope. Thirty miles below its head where I judged the grade to be no more than 2%, lava and limestone boulders six to ten feet in diameter were common. (See photo 18.) The material in this fan is well rounded and unconsolidated and the fan is of wide extent north and south, as far as one can see. It might be supposed that this is a huge mud flow from recent eruptions of Mt. Orizaba but for its tremendous extent and perfect symmetry. Mud flows tend to be intermittent in time of eruption and therefore to form in ridges or tongues with steep frontal slopes, rather than flat sheets.²⁰ Also, it is very unlikely that mud could carry such large boulders on so low a gradient, for a mud flow that contains such a high percentage of boulders and coarse gravel is not a frictionless mass and will come to a stop as soon as the slope levels out to any degree. Pure mud on the other hand, is quite a different matter and will flow on a very low gradient, almost like water. Indeed, it is quite a mystery how so many boulders got into this fan for it might better be called a boulder flow. The boulder gravel in this fan is unusual in another respect, in that it does not show any particular sorting, the stones near the top of the fan being about the same size as those 30 to 50 miles below. In fact we saw some big, nearly round boulders, no more than 15 miles inland from Veracruz. One of these was at least four feet in diameter. This condition points to oceanic flooding because a great volume of water charging against the Mexican Plateau, would recede with increasing power and carrying capacity at lower elevations.

The gravel material in this fan is easy to see and study because of the open nature of the country. Near its head in the tropical rainforest, the highway cuts across the deep canyons and there reveals in the cut-banks, a good cross-section. Farther down the fan in the agricultural country one may see the boulders in the fields and in the vertical walls of the river banks and still farther down the fan, the climate changes to a desert and only a little cactus shields the landscape from view. At one place about 20 miles below the city of Cordoba we climbed an old Aztec pyramid and from its 60 foot elevation we could look to the horizon across this nearly flat country. It is difficult to see which way is down-grade.

Like many of the alluvial fans in western America, this huge fan is being cut by present day streams, their deep, narrow channels plainly indicating that the forces which built this fan were not like those operating there today.

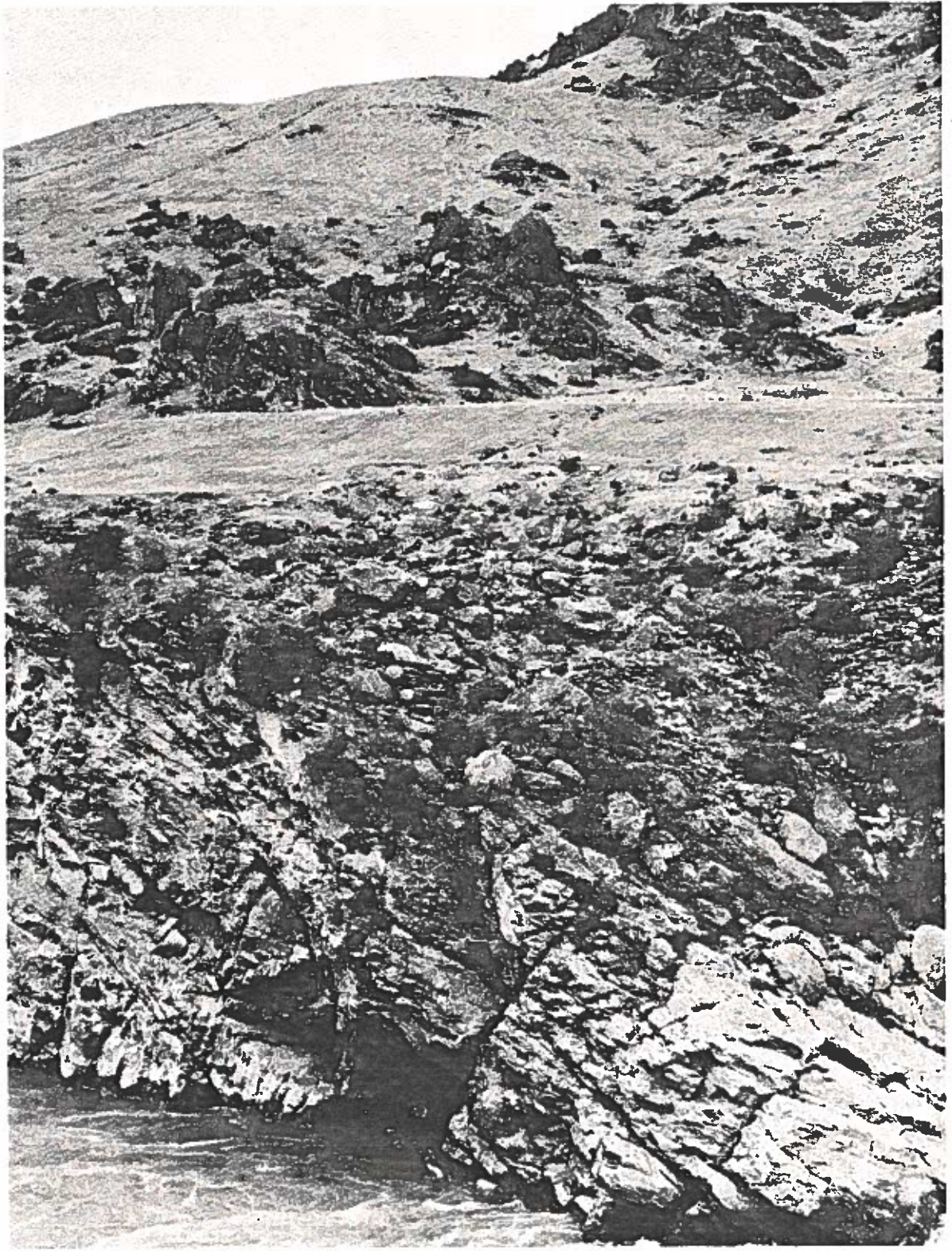
In recent years numerous deep sea investigations have proven that coarse sand, gravel, and even boulder gravel is not uncommon along the continental shelves and even on the deep sea floor.²¹ At one time this was thought impossible, it being held that the deep sea floor could only be covered with the finest muds and the organic deposits of tiny marine forms that inhabit the surface waters of the oceans and rain down their microscopic shells. The few samples dredged from the bottom had proven this to be true so it was thought to be universally true, and with good reason, for certainly neither rivers or ocean currents could carry gravel or large stones away from the shore. When gravel and boulders were later found far from land, it was thought that they had been carried by ice, but as more deposits were found far from the possibility of ice transportation, it became evident that some other explanation was necessary.

There are many more deposits of erratic sediments in Mexico, New Zealand, Australia and Peru that could be described, but this should suffice to show the wide-spread nature of these sediments and some of the problems involved. Only one other point might be made and that is the complete *lack* of erratic sediments in some places such as Fiji and eastern Australia where unconsolidated sediments are not seen except in river bottoms. Here the bedrock on the hills is only a few inches below the surface and we see the possibility that recent oceanic flooding may have removed all of the old soil and surface sediments, washing them into the sea.

A somewhat similar condition may be seen on the western slope of the Sierra Nevada range in California, where late Pleistocene glaciation has left its marks everywhere in the higher elevations in the form of glacial polish and striations, yet rock debris in the form of moraines is almost completely lacking. In contrast, the eastern side of the range has large glacial moraines in every canyon of any size.

All these anomalies and unusual conditions that do not fit the current geological explanations of origin, will fit the theory that cosmic bombardment may have been the primary cause of most of the earth's massive sedimentary deposits.

The basic premise of collision geology is that the earth is a part of the solar family, including the asteroids; that its history cannot be separated from these little brothers, and that collision with them has always been a part of that history; that most of the wide-spread and gigantic features of the earth are of collision origin and must all be taken together and studied together



19. Flood gravels high above the Clutha River, South Island, New Zealand. Boulder gravel is seen on top of the bedrock and beyond a gravel bar stretches across the picture. Upper left, a part of the highest gravel bar that may be traced all along the walls of this canyon, its top about 350 feet above the river.

as a whole, rather than piece-meal and in separate fields, as orthodox geological science seems to prefer.²²

To compare basic principles: Orthodox geology maintains that present day earth *forces* are the keys to understanding the earth features made in the past. Collision geology holds that the *physical features* of the earth are the keys to understanding the forces that made them.

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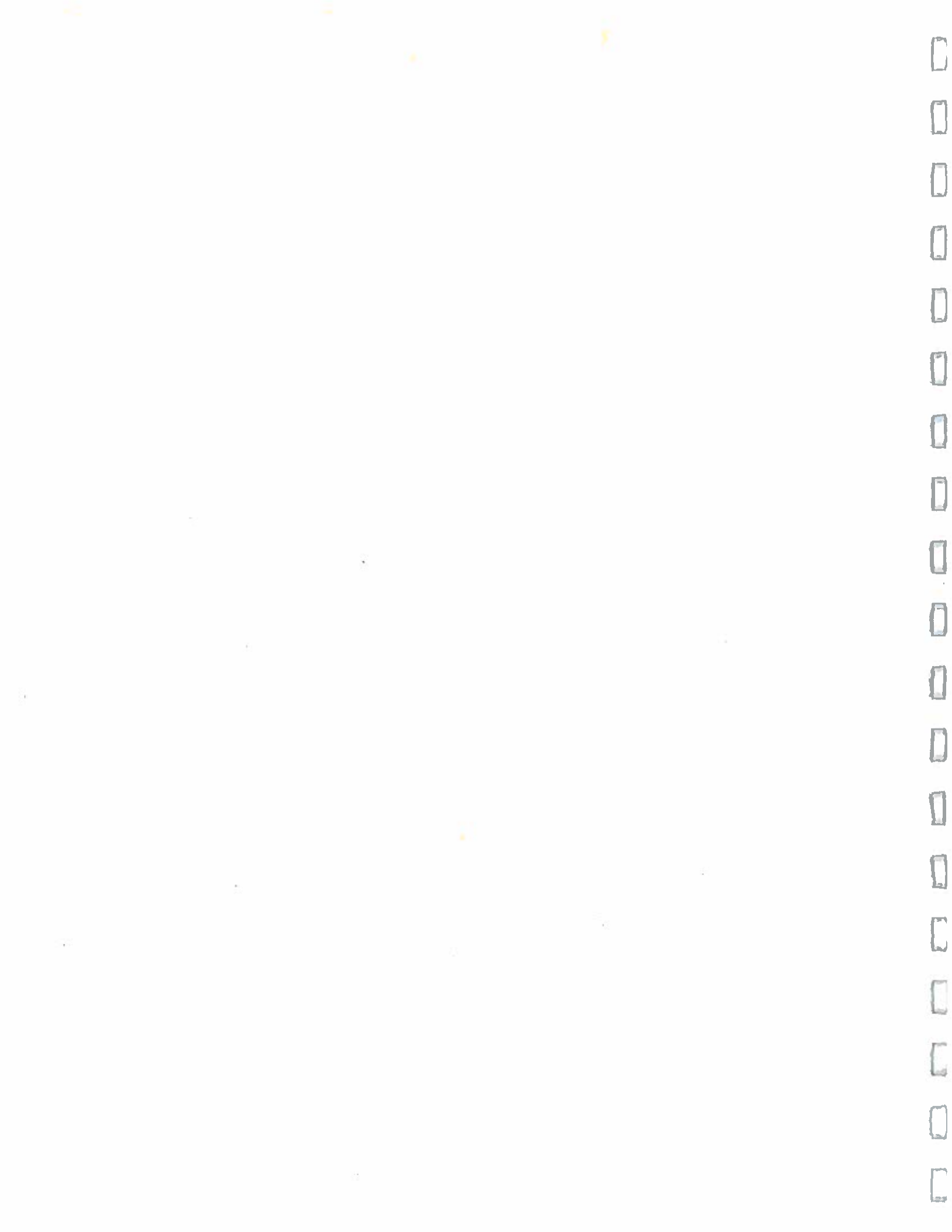


**METEORITIC KETTLE LAKES:
A CONSIDERATION OF THEIR ORIGIN**

By

ALLAN O. KELLY

January, 1963



Lakes are among the most beautiful and romantic of all Nature's wonders yet from a geological standpoint, they have hardly received their full share of attention. The tens of thousands of small lakes that dot the plains of Canada, Alaska, the United States and Australia, have to a great extent, gone un-noticed, (probably because they are so commonplace) and little thought has been given to their origin.

The purpose of this paper is to discuss some of the anomalies connected with these lakes, and in order to do this, and to make clear what kind of lakes are under discussion, it is proposed that a simple classification of lakes be made according to the forces that made them:

1. Those forces generated from within the earth.
2. Those forces generated upon the surface of the earth.
3. Those forces coming from without the earth.

TABLE I

TECTONIC	SUBAERIAL	METEORITIC
Volcanic crater lakes	Glacial basin lakes	Meteor crater lakes
Earthquake subsidence	River Oxbow & Delta	Kettle iceberg lakes
Rift Valley lakes	Landslide dam lakes	Oriented iceberg lakes
Range & Basin lakes	Beaver dam lakes	Saltpan iceberg lakes

With the above classification of lakes in mind, it is proposed to consider only the last three kinds in the METEORITIC column and to show that all are, indirectly, the result of major meteorite collision; a collision that shifted the polar caps of the earth about 30 degrees, caused world-wide oceanic flooding, and a host of lesser effects that cannot be considered here.¹

The term "Kettle Lake" goes back to the latter part of the 19th Century when the first intensive study of glaciation was taking place in North America and in Europe. The word kettle was used because these lakes are so obviously of the same origin as the kettle holes that form around stones or other obstructions in a stream bed, except that in this case, the obstructions were blocks of ice that melted and left the kettle basins.

Where these basins are very numerous, geologists have called them "Pitted Outwash Plains." This condition is thought to have come about by the melting of the continental ice cap that once covered most of eastern Canada and adjoining parts of the United States including the Great Lakes. According to Thornbury,² "Extreme pitting implies that the outwash sands and gravels were laid down over a nearly continuous mass of stagnant ice of irregular thickness. When this stagnant ice melted the gravel slumped to form hundreds of closely packed basins." This is the description found in essentially the same form in most geology textbooks. All of the American textbooks (fourteen) which I have consulted, confine their discussion to kettle lakes found within the United States. Nothing is said about the vast numbers of these lakes found in Canada, nor do they point to any likeness or connection

between these lakes and the Oriented Lakes of Alaska, the Carolina Bays, or the hundreds of thousands of similar lakes found in Australia.

All along the Trans-Canadian Highway, from Calgary to near the Lake of the Woods, a distance of 830 miles, the traveler is seldom out of sight of these lake beds. (See photos No. 1, 2 and 6.)

In traveling from west to east one sees the signs of gradually increasing rainfall with an accompanying change in the agriculture from a grazing country to a wheat growing country. The lakes change too, becoming smaller and deeper as the drift increases in thickness toward the east. They also vary with the precipitation from dry lake beds in the west that seldom contain any water, to swampy tree-filled basins and finally, to water-filled tree-lined lakes in the east.

The drainage in this country is mostly underground through the drift* so that few streams are seen on the surface draining one lake into another or into the few rivers that meander in wide loops across the plains toward Hudson Bay. This lack of surface drainage is also typical of the Alaskan lakes, the Carolina Bays and the dry lake beds of Australia, and we shall see later how this supports the collision theory of geology.

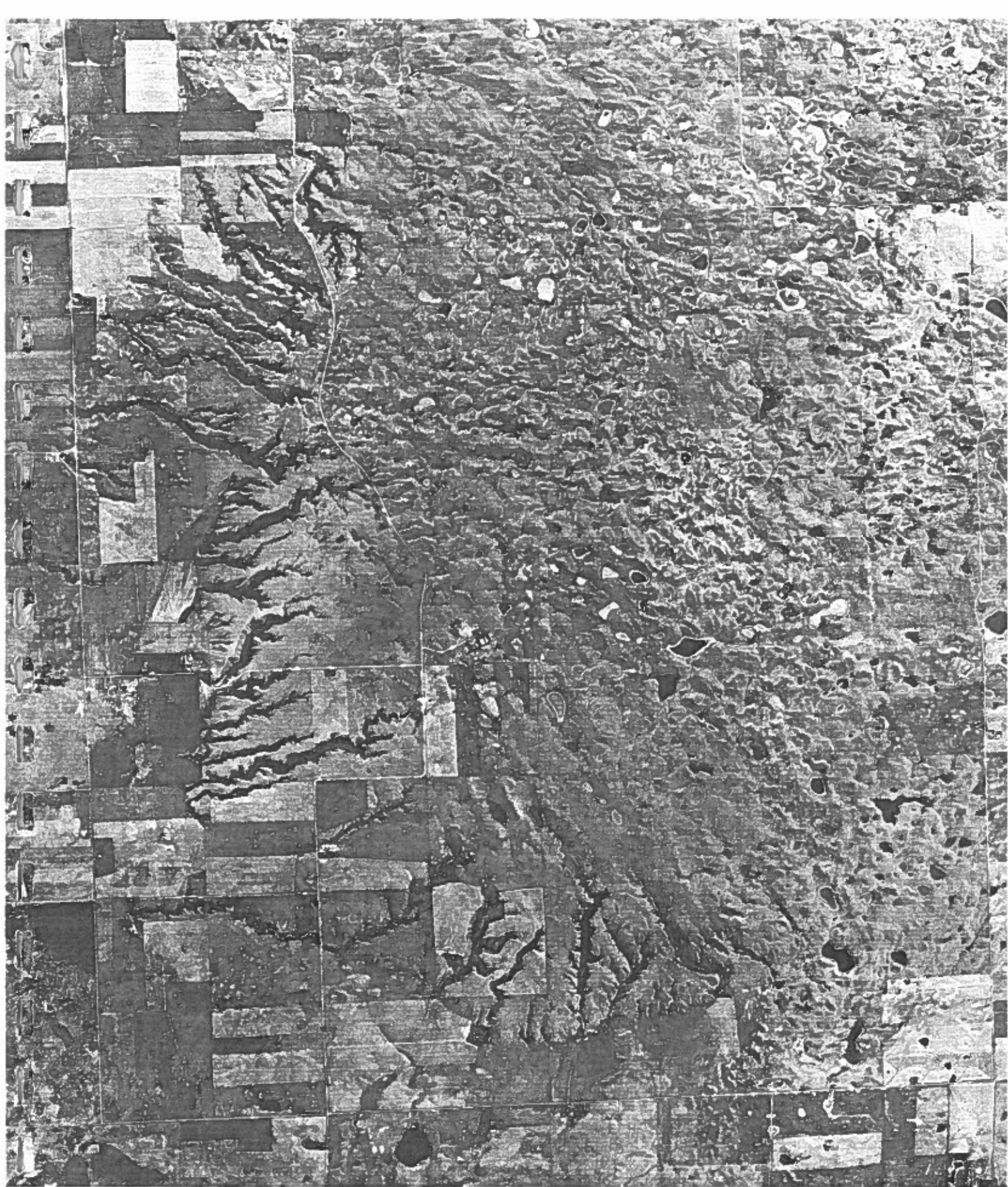
Seeing these geological anomalies from the ground, I decided to obtain a series of aerial photos from the National Air Photo Library in Ottawa where they kindly allowed me to examine hundreds of 9x9 aerial photos of this northern plains country. Aerial photos, of course, show many large features that cannot be seen from the ground. For example, some pictures show a water flow pattern covering wide areas where no river now exists and within this flow pattern lakes may line up in chains. (See photo 2) This is true of the area around Moosejaw and Regina, Saskatchewan. To the north, near Edmonton, there are sections where the flow pattern is in arcs and the lakes form irregular chains. (See photo 3) Other sections much farther north are covered with chains of very jagged or angular shaped lakes as if formed by angular shaped bergs that melted. (See photo 4) Along the shore of the Arctic Ocean near the mouth of the Mackenzie River there are whole groups of lakes that tend to be rectangular in outline. (See photo 5) Besides these areas of unusual features there are hundreds of square miles of drift* where the flow pattern is not seen and the lake beds are scattered at random. (See photo 6)

In the wheat farming sections where the land is divided by roads into square miles, one may easily count the number of lakes per square mile and counts of 30 or 40 are not uncommon. (See photo 6)

As indicated above these lakes are largest in the western plains of Canada and diminish in size toward the east. Many in the far west are as much as a half mile in their longer axis, but in the east where the land is more thickly populated with lakes, they average something near 300 feet in diameter. So much for the description of the Canadian kettle lakes.

In setting forth the Meteoritic Theory of the origin of kettle lakes, I shall first recount the

*Note. Drift is a term used for all sediments deposited by glaciers.



1. Area of lakes, live and fossil in an area of glacial gravel mounds, and a typical drainage pattern that goes nowhere. This area is three miles west of Moosejaw, Sas.

The random nature of the mound and kettle topography and lack of direction of the short drainage streams indicates an area where ocean waters had nearly come to a stop, a sort of half way point between the Arctic Ocean and the Gulf of Mexico.



4. Sharply angular kettle lakes in the Peace River Valley about 175 miles south of Great Slave Lake and about 200 miles west of Lake Athabaska ... $58^{\circ} 18' N$ and $116^{\circ} 35' W$.

The drift appears to be deep around the lakes and a definite flow pattern is seen in upper right of photo. The lakes on the left are nearly all frozen over and are laid out in a pattern from left to right as if roughly parallel strings of icebergs had grounded here. The high shorelines are on the south side of each lake and the drift slopes from the top of this high shore, on a long slant to the flat shore of the next lake to the south.

Courtesy of Library Surveys
and Mapping Branch, Canada



5. Angular shaped kettle lakes in Old Crow River basin headwaters of the Yukon River in Canada. 68 degrees north and 140 west. The elevation of this basin is about 2500 feet and the British mountains and the Richardson mountains lie between this upper Yukon basin and the Mackenzie River Valley and the Arctic Ocean.

Note: blanket of drift covering the right hand side of the photo. Multiple shore lines on some large lakes and abrupt bluffs on other lakes. The latter appear to have been made by the drift packing in around the icebergs to some depth and then freezing and later growing a cover of tundra. When the iceberg finally melted it left a perpendicular bluff as the lake shore.



6. Area of lakes, fossil lakes and semi-fossil lakes about three miles east of Virden, Manitoba. Virden is about 20 miles east of the Saskatchewan line.

Courtesy of Library Surveys
and Mapping Branch, Canada

presently accepted theory of the so-called "Ice Ages" so that the lay reader may have some basis of comparison: This theory holds that during Pleistocene time (about a million years in extent) continental ice sheets advanced and retreated four times in North America. The first and most widely spread has been called the Nebraskan because it reached into Nebraska; the second Kansan; the third Illinoian and the fourth and last, Wisconsin. The Wisconsin has been divided into four substages.

Between each of the four glacial advances there were long periods of warmer climate known as interglacial periods and named from the oldest, — Aftonian, Yarmouth and Sangamon.³ According to radio-carbon dating, the Wisconsin came to a close about 11,000 years ago, the ice melting quite rapidly. This last retreat was the time when "the outwash gravels were laid down over a nearly continuous mass of stagnant ice of irregular thickness, which later melted and caused the pitted outwash plains."⁴

My objections to the above geological picture are as follows:

1. There is no physical proof, such as glaciated basement rock, to prove that continental ice actually covered the vast area of the drift, which extends all the way from the Arctic Ocean, down across the plains of Canada and around the Great Lakes to the Atlantic Ocean.
2. Almost everywhere the drift is as high or higher than the bare, glaciated rocks of the Canadian Shield which extends from the plains country to Hudson Bay. There is no doubt whatever that these bare rocks were glaciated by continental ice. (See photo 7) The rivers of the lower plains country now flow eastward through the drift and across the Canadian Shield into Hudson Bay or northwest around the shield into the Arctic Ocean. The western edge of the drift where it joins that from the Canadian Rockies, reaches an elevation of roughly 4,000 feet⁵ while on the eastern side next to the bare rock of the glaciated area, its elevation is about 2,000 feet. It can hardly be claimed that all this outwash gravel was carried uphill by the meltwater from the continental ice sheet.
3. Most geologists agree that the tremendous weight of the ice sheet depressed the Canadian Shield as much as 1,000 feet and they have good evidence to prove it in the old high strand lines.⁶ This being the case, the land surface toward the Rockies must have been even more up-grade than it is now, adding to the difficulties of drift transport.
4. If the retreating ice front melted over a period of only a few hundreds years, outlying blocks of ice would melt too, (within a short time-lag) and meltwater from the retreating glacier would soon fill their depressions with gravel, although it seems very unlikely that the great mass of ice would melt and leave any small outlying blocks. However, the evidence *does* indicate that great numbers of blocks of ice did melt all at the same time, and *after* there was any movement of water to fill the depressions with gravel.

Applying the meteoritic collision-flood theory we get a much more logical answer: We begin with a pre-collision polar ice cap roughly the size of the earth's present Arctic Circle. This was centered about 60 degrees north and 60 degrees west. Its western side covered all of the glaciated area of the Canadian Shield in a great arc extending from the Arctic Ocean down around the Great Lakes and to the Atlantic Ocean. The ice over Hudson Bay was probably two miles thick as glaciologists have estimated and the ice conditions of Greenland were the



8. Typical glaciated country of the Canadian Shield. West Hawk Lake, elevation about 1200 feet is located about three miles west of Kenora, a resort town on The Lake of the Woods. Recent gravimetric surveys by Dominion Astronomer Dr. C. S. Beals, indicate anomalies that may mean this lake is of meteorite impact origin. It averages over 150 feet in depth, much deeper than similar glacial lakes in this area.
The arc outlined at top of photo may be a segment of a much larger impact crater.

same as today because the old polar cap covered all of Greenland as it does today. The Rocky Mountains and the Coast Range supported much larger glaciers than they do today and north-western Europe, being then much closer to the old pole, was covered with glaciers too. (See Figures I & II)

When the last great collision occurred (about 11,000 years before present)⁷ it moved the polar caps to where they are now and the oceans over-ran all of the lower elevations of the earth.

All of the outer edges and thinner portions of the old ice cap were shattered by the collision shock as was the sea-ice in the polar regions. The drifting sea-ice was carried in over the land where it stranded and the edges of the ice cap were broken off and floated outwardly where they mixed with the vast fleets of sea-ice carried inland by the oceanic flood. Since ice floats with 9/10ths of its mass under water, the icebergs grounded long before the ocean waters

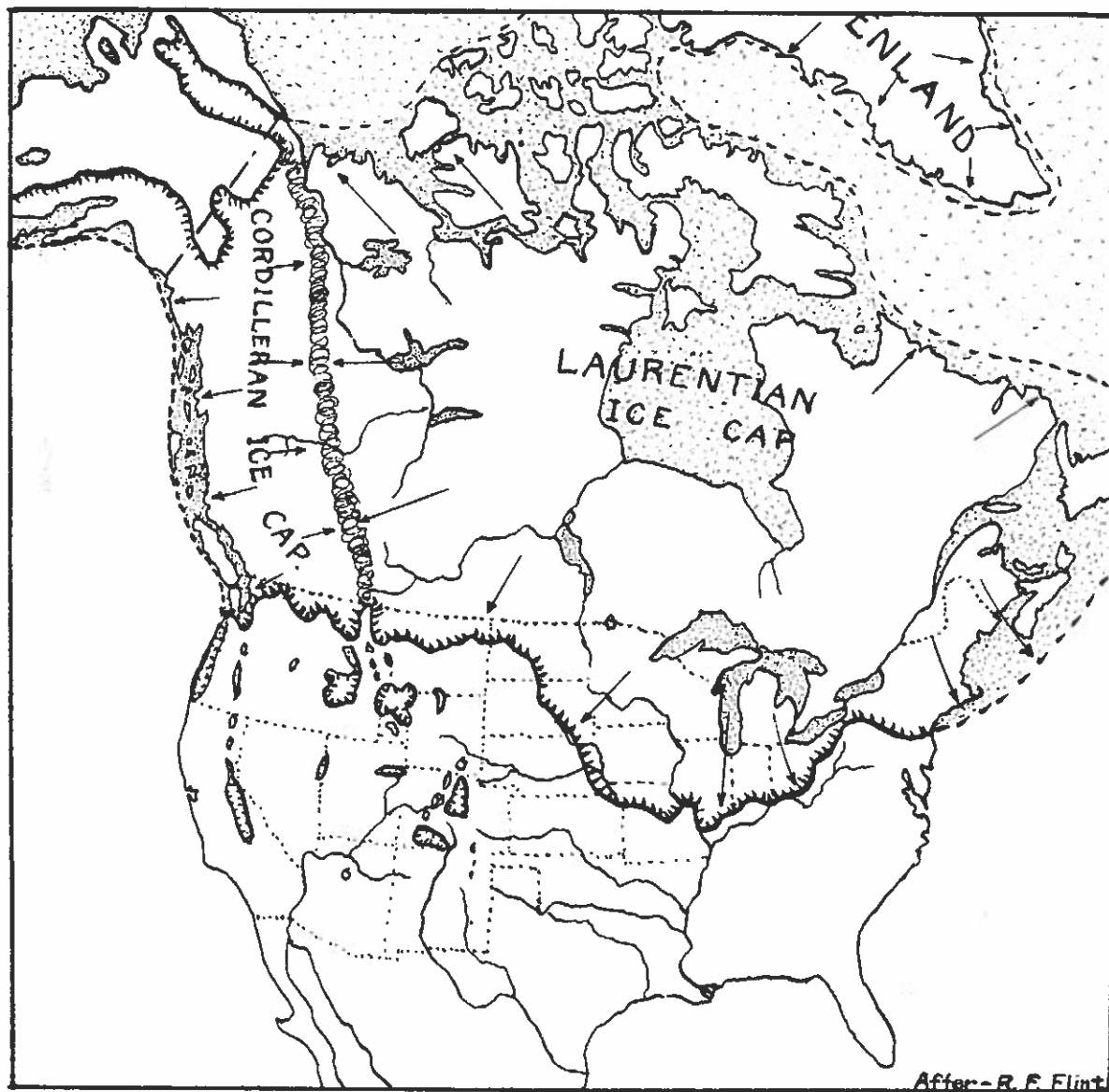


Figure I.

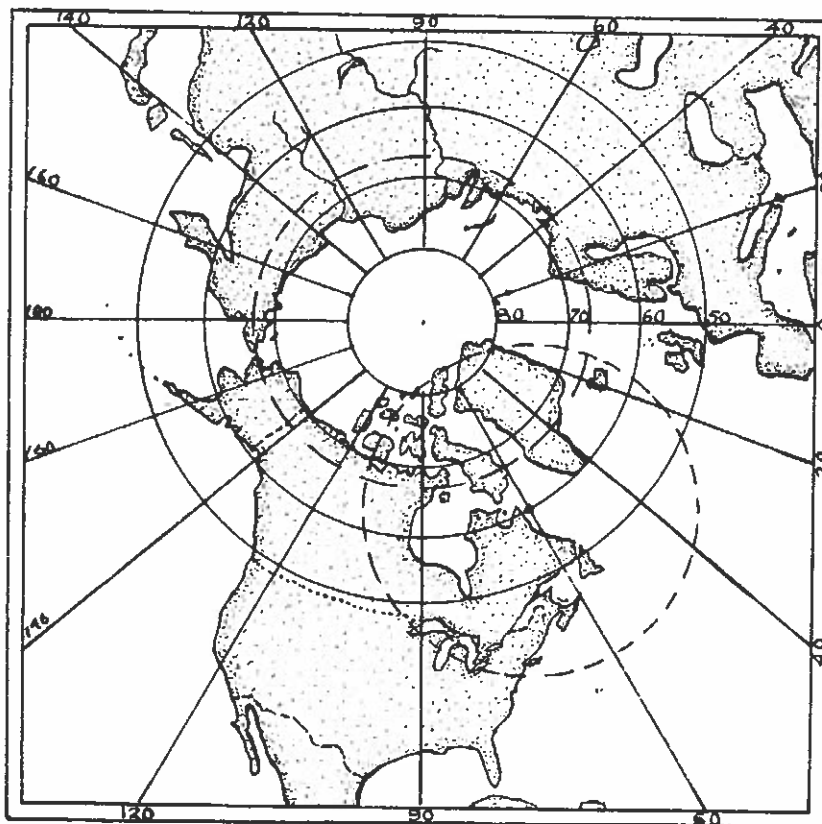


Figure II.

Map showing Pre-Pleistocene polar cap in relation to Northern Europe and Siberia and to the present day north polar area.

moved off the land. This accounts for the tremendous quantities of gravel (drift) deposited around the stranded bergs. The ocean water moved off the land quite quickly and allowed the bergs to melt, — slowly, if along the Arctic Ocean near the new pole and more quickly, if in the Carolina Bay region far removed from the new pole. The great numbers of triangular and rectangular kettle lakes in the far north along the Mackenzie River Valley and the shores of the Arctic Ocean is a strong argument for iceberg formation and for slow melting. Permafrost has preserved these iceberg kettle lakes almost intact.

The Great Lakes must have contained ice of great thickness, probably at least 2,000 feet above present levels so that the oceanic flood was not able to float these great masses of ice out of their deep basins. It did, however, pile vast quantities of gravel against these ice mountains so that even today, eleven thousand years later, the rivers head right against the south shores of the Great Lakes and flow south into the Mississippi system while the lakes themselves drain northeast into the St. Lawrence River. The Great Lakes then, are only giant kettle lakes formed in much the same way as their little brothers.

Geologists have never given much credence to the theory of shifting polar caps but have held to the idea that the "Ice Ages" consisted of a series of cold cycles interspersed with much longer periods of warm climate during which the ice retreated great distances or disappeared

altogether from the Hudson Bay region and from the high mountains in other parts of the world. In the United States they claim to find evidence of four advances and four retreats of the continental ice sheet. (We are now living in the fourth retreat.) The evidence for this they see in the terminal moraines that they believe mark the farthest advance of each of the "Ice Ages,"—Nebraskan, Kansan, Illinoian and Wisconsin. Each of these advances, they claim, produced a blanket of drift as the ice front retreated, and each of the blankets was topped by a deeply weathered soil surface that had accumulated over the many thousands of years of warm interglacial climate.* It is admitted by some glaciologists that four distinct surfaces of gumbotil are not everywhere present in the drift, but that they may be found in some localized places.

I do not doubt the existence of these distinct layers of drift. I *do* believe, however, that they were made by deep flowing ocean water moving to and fro, rather than by ice advancing and retreating. It is difficult to believe that continental ice could over-run old beds of drift a few tens of feet thick and not plow it up and thoroughly mix it with the fresh debris it was carrying. That this could happen four times and leave any undisturbed spots anywhere, is beyond belief. Nor can I understand why each advance of the ice fell a little short of the last advance so that each of the four terminal moraines can be counted. This seems too much to expect from the random nature of climate and other earth forces.

I suspect that the entire thickness of the drift is one deposit of many different ages and many different materials all mixed together. The several layers are the result of several returns of the ocean waters as gigantic tides. The farther inland and the higher the elevation, the fewer were the layers deposited. The first inundation after collision was the largest and most violent, but the ocean water had to come to a stop somewhere, against some mountain wall or against other ocean water coming from some other direction. As it slowed down it dropped the coarser gravel and when it came to a stop the finer material was deposited. Then as it moved back toward the ocean basins, probably at an increasing speed, not much sediment was deposited until the tidal forces had subsided to a great extent. Returning inundations were smaller and less violent, but each came to a stop and each made its deposit, but not always in the same place, or of the same thickness or of the same material. Somewhere in these beds of drift, one should find cross-bedding, showing the direction of flow. The lower beds should contain coarser material and the upper beds grade into finer material. The layers of leaves, sticks, logs and other organic material should be found in a band marking the farthest advance of each tidal inundation. This depositional effect can be seen anywhere storm waters drain off the land slowly or where floating debris is left by tidal waters along the beach or on mud flats.

Geologists have taken these successive layers of gravel and organic debris to mean successive invasions of the continental ice front: According to Miller,⁹ "It has been established that the front of the great continental glacier underwent many more or less local advances and retreats. In the northern Mississippi Valley there is positive proof of several (perhaps five or six) important advances and retreats of the ice which gave rise to true interglacial stages. The strongest evidence is the presence of successive layers of glacial debris, a given layer often having been oxidized, eroded, and covered with vegetation before the next (overlying) layer

was deposited. In drilling wells through the glacial deposits of Iowa, for example, two distinct deposits or layers of vegetation are often encountered at depths from 100 to 200 feet. Near Toronto, Canada, plants which actually belong much farther south in a warmer climate have been found between layers of glacial debris. Thus we know that some, at least, of the ice retreats produced interglacial stages with warmer climate, and that they were sufficient to reduce greatly the size of the continental ice sheet, or possibly to cause its entire disappearance."

The above reference to the finding of plants native to warmer climates is not at all unusual in this area. The bones of Pleistocene animals such as mammoth, the bones of whales and seals, all have been found at the very edge of the heavily glaciated area. During the IGY, members of a party of glaciologists led by Troy Pewe found quite a number of mummified seals in the ice-free area near McMurdo Sound in Antarctica.¹⁰ Some were found up to as much as 2500 feet above sea level and 45 miles inland. These misplaced plant and animal remains may not mean that a warm climate prevailed for thousands of years or that sea level once stood hundreds of feet higher. It may only mean that oceanic floods transported these relics, depositing them against mountains of continental ice or in other unusual places. In support of this supposition, it is known that many of the large lakes of the world contain marine forms of life that could hardly have reached these lakes except by oceanic waters having over-run the area.¹¹

Since the advent of radiocarbon dating, about 1950, hundreds of age determinations have been made of glacial deposits, but it would seem that not too much confidence can be placed upon such information because of the uncertainty of the order of deposition. Either of these dynamic forces (glaciation or oceanic flooding) could have cut into much older gravel deposits containing carbonaceous material of many different ages, mixed all of this together, and deposited it again in an entirely erratic order. Under these circumstances it would seem logical to look for an oft-occurring date in the drift or to look for exceptionally deep deposits of logs or other plant debris that might indicate the uprooting of whole forests of trees and their transportation and stranding by cataclysmic flood. Such a re-occurring date has been suggested by Dr. Libby¹², 11,000 years before present, plus or minus 200 years. Dunbar¹³ mentions this date as follows: "A particular significant locality is at Two Creeks in Wisconsin, where a fossiliferous deposit occurs immediately below the Mankato till and is dated as 11,000 years old. This dates the last significant advance of the ice in this region and proves that the ice age was not over. Clearly this advance did not reach into southern New England and there is abundant evidence that the ice disappeared rapidly between 10,000 and 11,000 years ago."

Many more carbon 14 dates are needed on the drift but it would seem of more value to concentrate on radiocarbon dating the frozen animal remains in the Yukon and in Siberia. If all of these frozen remains are found to be of the same age, in widely scattered parts of the world and whether buried deeply or near the surface of the drift, then we may be quite safe in assuming that they were all buried by the same great cataclysm.

My explanation of the terminal moraines as found in the upper Mississippi Valley (which glaciologists take to be the evidence of four separate ice ages) is that they are the product of

the same oceanic flood as outlined above. Probably the shock waves from the collision shattered the continental ice cap and long narrow strips of ice from its edge were floated outwardly until they grounded. On coming to a stop, they probably plowed up long ricks of rock and other debris and dropped whatever rock they were carrying when the ice melted. Under these circumstances, any native rock plowed up might show great age by having weathered near the surface of the ground, while the transported boulders (at least those that had been in contact with bedrock) would be smoothed and polished. It must be remembered that glacial ice can pluck angular stones off the bedrock, and under varying conditions of topography and pressure, polish one side or more, or none at all. It may be quite possible then, to find boulders of different degrees of weathering, different kinds of rock, and varying amounts of striation or polish, all in the same terminal moraine. This would be true whether the ice floated across country to its grounding point or moved over the ground as glacial ice. In the second case, the bedrock underlying the drift should be glaciated all the way, whereas, if it floated, there would be skips. There is said to be a so-called "driftless" area in Wisconsin which may be one of these skipped over areas.

Another indication of oceanic flooding as seen in Canada is the presence of large, erratic boulders in the old lake beds that are scattered by the thousands over the central plains of Canada. These lake beds are often so shallow that the tops of the boulders are nearly as high as the rims of the lakes, often as much as two thirds of their mass above the surface of the dry lake bed. This indicates to me that these boulders were floated to their resting places in icebergs and not pushed hundreds of miles across the plains in a mass of continental ice. Also, there is no other indication of ground ice such as kames, eskers, or terminal moraines; at least none that one could see from the highway.

Another interesting phenomenon, is the fact that some of these lake beds contain granite or other pre-cambrian rocks from the Canadian Shield, while others close by contain sandstone or quartzite boulders that must have come from the Canadian Rockies on the west. This would lead one to believe that glacial ice from both sides of the plains country mingled in one great, swirling, flood, before they stranded.

Continuing into Alaska we find numberless thousands of these lakes including the famous Oriented Lakes around Point Barrow. The number of these lakes is positively fantastic! There are hundreds of square miles of them around Kotzebue Bay north of the Seward Peninsula; the whole delta of the Yukon River is covered with them as is the north shore of the Alaskan Peninsula and the shores of Kvichak Bay. Those on the north Alaskan plain stretch for 400 miles east and west and more than a hundred miles north and south, covering an area of more than 26,000 square miles.* Those on the Yukon delta cover more than 26,600 square miles and the Alaskan Peninsula carries along its north shore on patches of low ground, a total length of 360 miles of these lakes, with a width varying from a few miles to more than forty. St. Lawrence Island in Bering Sea, has many of these lakes on low ground between the mountain peaks, and across the Straits on nearby Chukotsky Peninsula, other thousands have been described by the

*Note: See Rand McNally Imperial Map of Alaska, 1958

Russian geologist, Zenkovitch.¹⁴ Even the upper Yukon Valley which is wide and flat around Fort Yukon is covered with these kettle lakes. It is my belief that all of them are the product of stranded sea ice that came out of the Arctic Ocean and from along the Canadian Archipelago, then the edge of the old polar ice cap. (See Figure III and Photos 9-10-11-12.)

The oceanic flood that transported this vast fleet of icebergs was also the agent of destruction that buried the countless numbers of Pleistocene animals that have been exhumed from the gold-bearing gravels of the Yukon.¹⁵

The Carolina Bays along the southeast coast of the United States as well as the lakes on Cape Cod and along the New Jersey coast, are, I believe, of the same iceberg origin except that in this case, the ice came from the Atlantic Ocean. Like the Oriented Lakes of the Point Barrow region, only the large coastal lakes are oriented in one direction (northeast) their longer axis being quite parallel. Also these lakes decrease in size with elevation and distance inland from the coast and the orientation gradually disappears, as is the case around Point Barrow. It is significant too, that these lakes do not contain erratic boulders in their shallow, flat beds, a good indication that they were made by flat-bottomed cakes of sea-ice rather than glacial ice from the land. (See photo-8.)

Most of the minor differences in the outlines of the Carolina Bays and the Oriented Lakes of Alaska such as multiple rims or lack of rims, or drainage pattern, can be attributed to the very great difference in climate that prevailed following the collision and the shifting of the earth's polar caps. For example, the stranded ice cakes must have remained in the Alaskan lakes for many years because this area was moved into a colder region. Point Barrow, once a thousand miles below the Arctic Circle, was moved to its present location 300 miles above the Arctic Circle. Myrtle Beach in South Carolina, where some of the largest and best oriented lakes are found, was then only 400 miles south of the Arctic Circle which passed through Baltimore, Maryland. Now Myrtle Beach is 2200 miles south of the Arctic Circle. (See Figure III.)

The ice cakes melted quite rapidly in the Carolina Bay region and especially on the sunny side of each cake, so that multiple rims of ovoid shape were formed on the southeast side of each lake.¹⁶ Also, vegetation grew much faster in this warmer climate so that most of the Carolina basins were soon filled with swampy growth. Now they are best described as fossil lakes whose outlines can only be seen from the air. Thus we see an evolution in lakes of the same origin, that moves at a different pace under different climatic conditions.

The orientation of these lakes both in Alaska and along the Carolina Coast, may be explained as a massive water-flow alignment. The ocean water moved in and out as one mass hundreds of miles in width, returning many times over these coastal plains. When the ice cakes first grounded, the longer axis of each cake would align itself with the direction of water movement. Thus, all the lakes are oriented in one direction because the ocean water carrying them moved as one mass and not as a series of minor tidal waves flooding adjacent river valleys. Once the ice cakes were firmly stranded, the water continued to flow in and out among them and to deposit sand and gravel against them. In this way the stream channels developed between the ice obstructions and when the ice melted it left a series of flat bottomed basins each draining

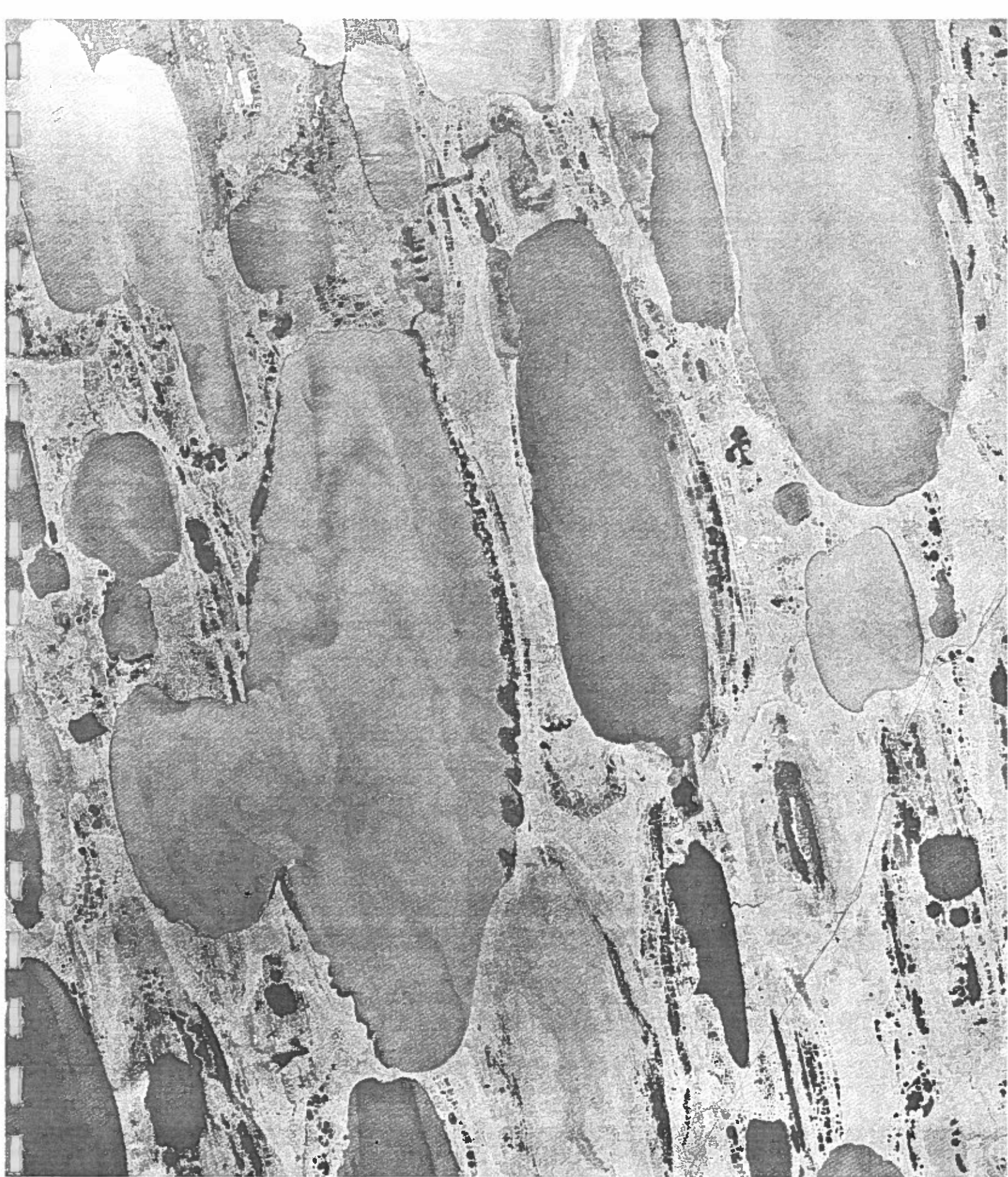


Figure III.

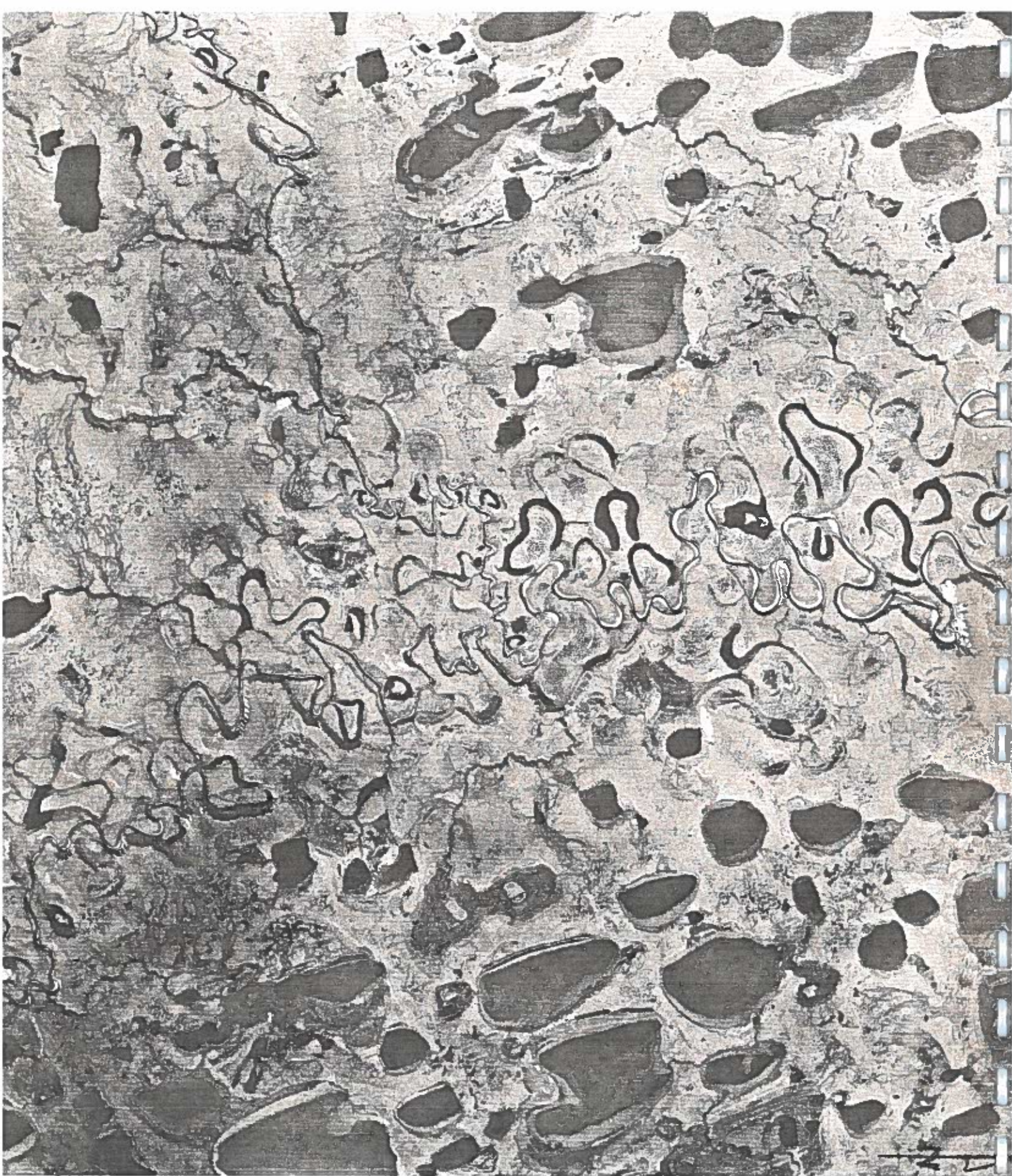
Map showing area of old polar cap and present day river drainage system. Stippled areas show extent of kettle lakes and also the drift.



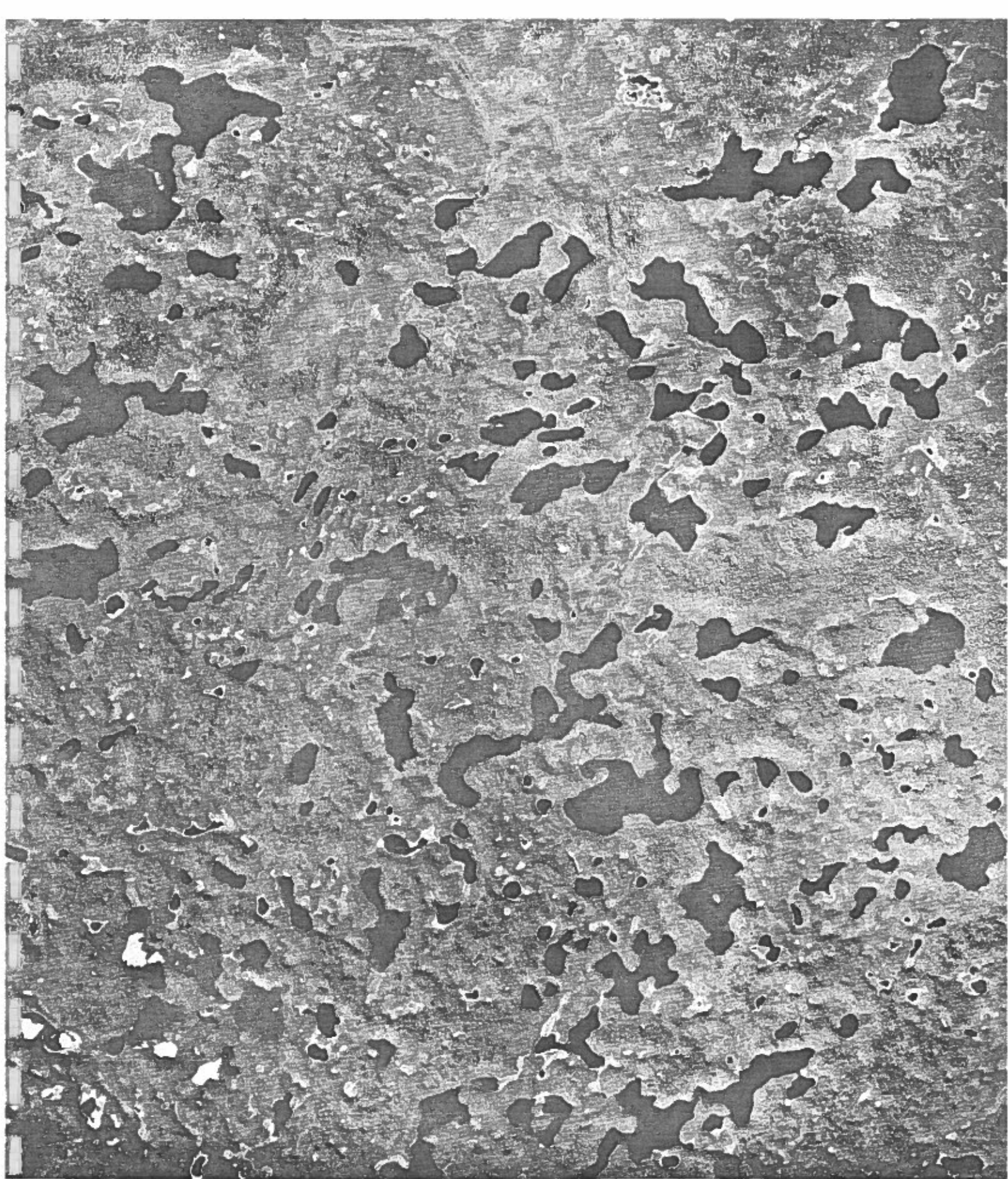
9. Oriented lakes of medium size about 80 miles south of Barrow, Alaska. North is at the top of the picture and the lakes point in a direction a few degrees west of true north. The water is very clear and the bottom and sloping shores may be seen to perfection.



10. Large oriented lakes about 10 miles inland from Sinaru, an Eskimo village on the coast about 40 miles SSW of Barrow, Alaska. North is at top of the picture. Multiple shore lines are in evidence around all of these lakes, probably caused by slow melting of the large cakes of ice that once stranded here. Ice would strand easily because of its deep submergence in the water and because its great momentum would cause it to plow deeply into the subsoil.



11. Oriented lakes along the Ikiqpah River about 125 miles southeast of Point Barrow, Alaska. These lakes are near the southern extremity of the Alaskan plain and are not as large as those near the coast. The meandering river shows that the plain is very near level. White sand bars and cut banks may be seen along the river as well as oxbow lakes that have been cut off from the river.



12. Iceberg kettle lakes on low ground along the south shore of Cook Inlet about 40 miles SW of Anchorage Alaska. There is no orientation or regularity of shape in these lakes but they appear to be fairly deep. There is no lighter shadow around the shores indicating shallow water.

into its adjacent stream, never from lake to lake as in other lake country.

Such a collision would generate many interacting mechanical motions; in the air, in the water and in the earth itself; but vast areas of the ocean would most surely move as one mass. These oriented lakes are strong evidence that a major collision did occur.

This brings up the question of whether the axis of the earth has actually been changed, in its relation to the sun, or whether the polar caps as part of the crust, slipped upon the mantle and core thus presenting a new surface to the rays of the sun. These are questions of geophysics and celestial mechanics which I am not competent to discuss. However, as a field geologist I can say, and I *do* maintain, that all of the evidence points to a change in the position of the polar caps and even the drifting of continents. On the other hand, there is *no physical evidence* to my knowledge, proving that the earth's polar caps or its continents, have always been in the same relation to the rays of the sun, or the continents to each other, and new evidence is constantly coming to light pointing to change.

It is very difficult, however, to change men's ways of thinking. As an illustration of this fact, I should like to point out that since 1948, there has been no less than eight field investigations of the Oriented Lakes of Alaska.¹⁷ Ten geologists, including eight Americans one Canadian and one Russian, all came to the same conclusion, that prevailing winds and waves acting in various directions (they do not agree on the wind direction) eroded the shores and produced these peculiar oblong lakes all pointing in the same direction. All of them projected present dynamic conditions into the past to determine the origin of the lakes. This is what they had been taught; the basic principle of geology. Not one of them saw that something had to form these lakes in the beginning; that wind and wave could not act to shape a shoreline until a considerable body of water was in place, a distance called the "fetch" that enables wind to build up waves of some size. Not one of these trained investigators asked himself, was this a grassy plain, a swamp or a forest before the lake appeared?

The Carolina Bays, being more accessible than the Alaskan lakes, have received much more attention from geologists and we also find, a great deal more divergence of opinion as to their origin.

Melton and Schriever, who discovered these lakes in 1933 while studying aerial photographs of the region, advanced the theory that they were made by a gigantic shower of large meteorites. Douglas Johnson of Columbia University, took the orthodox side, offering a hypothesis of complex origin of natural earth forces.¹⁸ Kelly and Dachille advanced the theory that they were ice formed kettle lakes resulting from a major collision.¹⁹ Many other geologists have studied the Carolina Bays and continue to do so, most of them taking the approach that the present is the key to the past and that primarily, wind and wave along with sundry other natural forces, have been the active agents.

In Western Australia there are thousands upon thousands of these kettle lakes that inhabit a desert and semi-desert region along the south coast, a strip about 500 miles long and perhaps 100 miles wide. There are other smaller areas in South Australia too. Very little study has been given to these small lakes, so far as I was able to find, but what literature was available

indicated the same manner or style of thinking. The Australian geologists see wind as the element at work in these deserts now so all have projected wind as the active agent of origin. Like their fellow geologists in the northern hemisphere, they disagree on the wind direction but all stick to the philosophy, – "that the present is the key to the past."

J. T. Jutson, who headed the Geological Survey of Western Australia for many years and who wrote Bulletin No. 95, "The Physiography of Western Australia," claimed that the dry lake beds in that region migrated across country from east to west.²⁰ This conclusion he drew from the fact that most of the lakes have a fairly steep slope on the western side, often bare and rocky, while the other side of the lake will have no rim at all. He reasoned that the wind was continually eating away the steep slope and casting it across the lake bed where it formed a low sandy rim. Vegetation taking root there, held the sand from blowing farther and thus the trailing edge of the lake kept in step with the leading edge. There is no prevailing wind there today as Jutson admits but he assumes there must have been in Pleistocene time.

In this very dry section of Western Australia one may look down from the air on thousands of these dry lakes ("Salt pans" the natives call them) and never see the slightest sign of a stream bed entering or leaving or connecting one dry lake with another. In the farming sections they usually appear as snow-white salt pans but in the very dry deserts the coloration is a light tan against a darker background. Most of the country is gently rolling and one may see salt pans on the tops of ridges, along the slopes or in the bottoms but never any stream beds to indicate that water ever ran into these basins. In outline they are well rounded, many of them almost perfect circles but so small that they are not shown on maps of the Country. (See photo 13.)

The lakes we do see on the maps of Australia are the large, irregular, salt lakes that cover hundreds of square miles in Central Australia. Lake Eyre and Lake Mackay are among the largest. I mention these range and basin lakes in order to distinguish them sharply from the small kettle lakes that are the subject of this paper.

Around the town of Norseman, in Western Australia, many kettle lakes are found in thick eucalyptus forests where the trees average 30 to 40 feet high. (See photo 14.) These lakes are quite large, averaging perhaps 1,000 feet in diameter. Many of them have the slopes on the western side, as Jutson noted, but sometimes the slope is on some other side or is lacking altogether. My explanation of this directional feature is that it was caused by a fleet of icebergs plowing into the ground as they came to a stop, thus bulldozing embankments on the western side. The exceptions were caused by uneven topography and water action.

As one travels south from Norseman toward Esperence, (a little town on the south coast) the countryside changes from a forest country to open farm land. Here the kettle lakes have no rims at all but the level sandy plain is pocked with hundreds of depressions 15 to 20 feet deep and two or three hundred yards across. Many have a shallow lake at the bottom surrounded by a ring of trees. The wheat farmers often clear the rim and farm down over the slope to the edge of the lake. These kettle lakes have never been full enough to run over since the time when they were formed because there is no sign of stream drainage from one to another. This lack of drainage is very apparent from the air, a fact I first noted on a flight from Adelaide to Perth.



13. "Salt pans" in South Australia on the Eyre Peninsula west of Adelaide.



14. Iceberg kettle lake in Western Australia near the town of Norseman.

Later in traveling by car through Western Australia and across the Nullarbor desert to Adelaide, I kept track of this lack of stream drainage in my daily notes. From Agnew, a ghost town in Western Australia where we camped in a dry creek bed, we did not see another stream bed of *any* size or kind for a distance of 1480 miles. Then another dry creek appeared near Elliston in South Australia. I include this bit of information because we always associate lakes



15. *Glaciated granite in foreground and part of the glaciated islands that lie off shore at Esperence, Western Australia.*

with streams and when one sees thousands of lake beds without streams entering or leaving, one begins to wonder about the present being the key to the past.

Most of Western Australia is a tableland about a thousand feet above sea level and it continues at this elevation, almost to the coast line. In traveling south from Norseman to Esperence we had become accustomed to the level country and were greatly surprised when we came suddenly to the edge of the plateau and looked down a thousand feet to a rugged, glaciated, coast line. Somehow we had expected to reach the coast by a gradual descent. The ocean for perhaps ten miles off shore was dotted with bare, granite islands, rounded and polished so recently, that scarcely a tree or shrub had found footing to grow. A little to the east along the coast, a big granite dome thrust its hundred acre mass some 500 feet above the shore. It had a few large boulders perched on its top. Below, the little town of Esperence nestled among a few sand dunes between two granite headlands.

Until I visited this south coast of Western Australia, I was not aware of the glaciation there, although I had read of that in Tasmania. (See photo 15.)

Upon inquiry in book stores in several Australian cities, I found that only one book on geology was available. This book, "THE FACE OF AUSTRALIA" by Charles F. Laseron, published in 1953 is not a textbook but a semi-popular work on the geology of Australia and Tasmania. Laseron says nothing about the glaciation in Western Australia but does mention that along the southeast coast and in Tasmania. He describes these glaciated rocks as being Pre-Cambrian in age and the glaciation as being of Permian age.²¹ To my eye it looks as fresh as any Pleistocene glaciation I have seen.

By way of approach to the subject of southern hemisphere glacial phenomena and in particular, as it may pertain to kettle lakes, we shall start in the northern hemisphere and project the old north pole (which we located at 60 degrees north and 60 degrees west) through the globe and locate its opposite, which turns out to be at 60 degrees south and 120 degrees east.

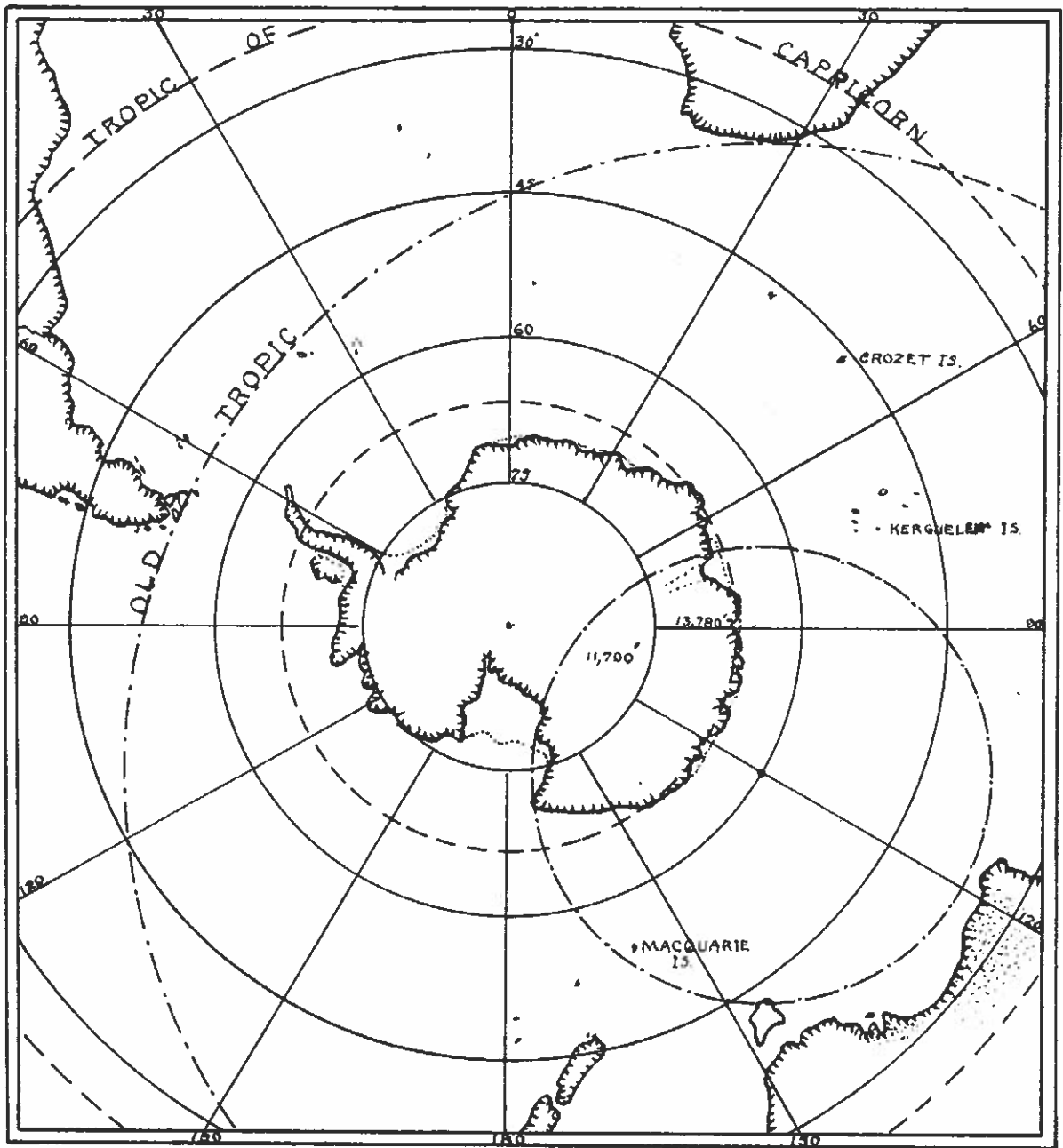


Figure IV.

Map showing old south polar cap and Tropic of Capricorn in relation to the present day south polar area and Tropic and to the continents and islands in the southern hemisphere. Stippled area in Australia shows kettle lakes there.

(See Figure IV.) As shown earlier, the old Arctic Circle encompassed all of the Canadian Shield, the arctic islands to the north and most of Greenland and Iceland. And its eastern side was close enough to northern Europe to account for the glaciation there. (See Figure II.) In like manner, an Antarctic Circle drawn around the pole indicated above, fits the Pleistocene glaciation of the southern hemisphere. It will be seen on the map that about three-fourths of this old south polar cap was in the South Indian Ocean and the other fourth overlapped the

Antarctic Continent. The north side of this circle almost touches the coast of Australia at Esperence following around the curve of the south coast and cutting across the edge of the island of Tasmania. When the south pole was at this location, New Zealand's glaciers were 900 miles closer to the pole than they are today, a fact borne out by the deep glacial trenches cut into the mountains of South Island. Milford Sound, a typical New Zealand fjord, is 1800 feet deep near its head ten miles inland, and its glaciated cliffs rise another 5,000 feet above the water. Pembroke Glacier, high up on one of the peaks along the Sound, is a small reminder of the vast glacier that filled this valley in Pleistocene time. In contrast to this condition, the Straits of Magellan, now in the same latitude as South Island, New Zealand, were then under the tropic of Capricorn. (See Figure IV.) Now the Straits of Magellan have glaciers discharging at sea level.

Turning to the Antarctic Continent, we see that the old circle entered the continent at McMurdo Sound and crossing over the ice cap, came out on the Lars Christensen Coast, encompassing about one-third of the continent. In this area, where the present polar cap overlaps part of the old polar cap, the ice conditions should have remained unchanged, probably since Permian time.²² A study of this area as compared to the Palmer Peninsula side of the continent and the glaciation there should be revealing.

All of the above evidence including the glaciation along the south Australian coast gives support to the theory that plenty of sea-ice was close at hand to form kettle lakes, when the last great collision caused the oceans to over-run all of the lower elevations of the globe including the continent of Australia. The presence of kettle lakes so widely scattered over the world and in such different climates is strong evidence that this did happen.

There are many other evidences of oceanic flooding in Australia, New Zealand and Fiji, which I have described in a book (now at the publishers) called "DOWN UNDER AND OFF TO ONE SIDE." All of the above anomalies and unusual geological conditions which do not fit the current geological explanations of origin, will be found to mesh quite reasonably with collision-flood geology.

The basic premise of collision geology is that the earth is a part of the solar family, including the asteroids; that earth history cannot be separated from that of the asteroids and that collision with them has been the great dynamic force in shaping the earth.

To compare basic principles: Orthodox geology maintains that present-day earth forces are the keys to understanding earth features made in the past.

Collision geology holds that the physical features of the earth are the keys to understanding the forces that made them.

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