The Takysie Lake, B.C., Stones: Meteorites or Moon Rock?

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Abstract. The first of the fusion crusted Takysie Lake, British Columbia, stones were found by Nininger in June, 1965. A field trip to determine the number and distribution of the unusual stones got underway in July, 1966. An intensive search of all accessible areas resulted in collection of 55 specimens with a total weight of 127.6 pounds. The apparent southern, western, and northern limits of the strewn field were established. The eastern limits could not be learned because of the heavily forested terrain. The unique structure and compositional characteristics of the stones indicate either a new variety of meteorite or a secondary meteorite of lunar origin. Suggestions are made for further investigation.

The first of the Takysie Lake, British Columbia, stones were discovered by Nininger in June, 1965, during a brief roadside stop while enroute to Alaska. Strolling along the shoulder of the road he noticed a peculiar stone the surface of which was partially covered with a grayish-brown crust, which, except for the color, resembled the fusion crust on old stony meteorites. The shape of the stone was irregular with blunt edges and corners such as characterize most stony meteorites (Figure 1) but the color was far too light for any but some of the achondrites.

Close inspection and a few simple tests showed that the crust was not organic growth or deposit. But grinding the stone with carborundum paper failed to reveal observable metal. The crust was gone from some areas of the stone, revealing a highly brecciated interior structure which had apparently suffered from being exposed. In the exposed areas and under portions of the crust, the stone had crumbled in a manner similar to the weathering seen in portions of Cumberland Falls, Potter, and Arcadia, indicating a composition unaccustomed to the weather. Alteration had occurred only to a depth of a few mm,

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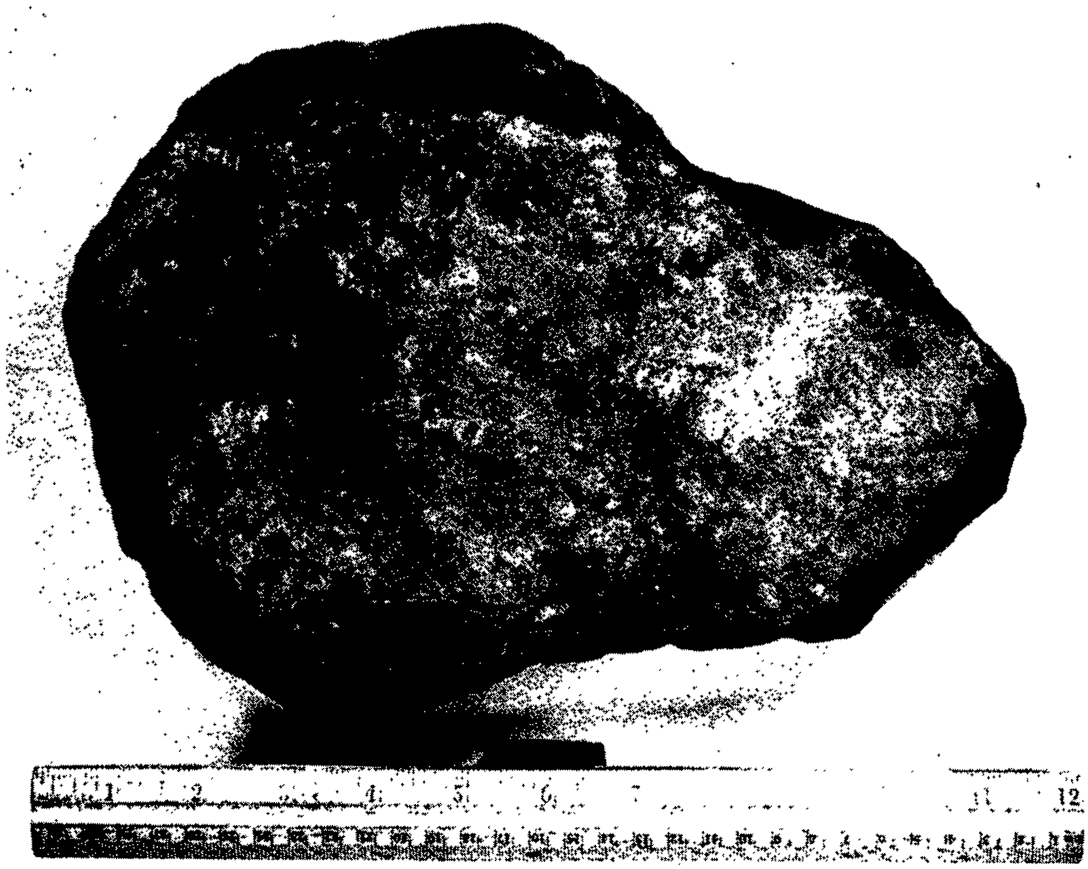

FIGURE 1—Largest stone recovered, 19.75 pounds.

indicating a relatively short exposure to weathering. None of the crustal material filled the pits made by the decay process, indicating that the crust had been acquired before the decay processes began. All of this seemed incompatable with the glacial deposit upon which the stones lay. Here granite, schist, basalt, quartz, and other of the usual glacial conglomeration lay uncrusted, showing the usual glacial shaping and, if visibly deteriorating, doing so by simply cracking and falling apart.

Concluding that he had found a specimen worthy of further study, Nininger continued his walk and soon found a second stone bearing the same characteristics. This somewhat shook his faith in the new find since one does not normally expect to find two stony meteorites of a fall within a few yards of one another. And when a third stone came into view, doubt took over completely. Further collecting was abandoned and the drive to Alaska was resumed.

But the presence of a fusion crust on these odd stones remained a disturbing problem. Other than aerial friction, only lightning could have formed the paper-thin crust and lightning would hardly strike only three stones of a particular variety scattered over an area of several square rods.

Under magnification the crust compared favorably in texture and configuration with the crust of stony meteorites. Carleton Moore, Director of the Center for Meteorite Studies at Arizona State University, reported that microscopic examination showed the crust to be definitely glassy. Analysis of internal material by Charles Lewis showed a silica content of 49.07 per cent.

A sample of the interior of one of the stones was sent to the Enrico Fermi Institute for Nuclear Studies to be tested for cosmogenic radionucleides. Deiter Heymann reported that testing with the mass-spectrometer showed the following results:

$$He^3 \leqslant 2 \times 10^{-10} \text{ ccSTP/g}$$
$$Ne^{21} < He^3$$

From this he concluded "a) that the specimen is not a meteorite, or b) that it is an object of uncommonly short radiation age, or c) that the sample came from deep (> 2.5m) inside an atypically large stone."

Careful examination of polished sections showed neither metal nor chondrules, a not unknown condition in aerolites, but the negative results of the testing for cosmogenic radionucleides failed to provide an answer to the origin of the fusion crust.

It was therefore decided to undertake additional field work to determine a) if this type of stone were generally associated with the glacial drift that characterizes a large portion of British Columbia; b) if this type of stone showed a distribution consistent with that of known meteorite showers; c) if its distribution and abundance were sufficient to provide for the deep shielding indicated by the tests made on the small specimen submitted to Enrico Fermi Institute; and d) if many of these stones were tested whether they might reveal significantly different radiogenic contents which would prove their space origin.

The Niningers and Glenn Huss and family reached the Takysie Lake region in mid July 1966, too late in the season to take advantage of the winter's effects upon the ground vegetation. The area of search (Figure 2) lay amid rolling glacially deposited hills covered for the most part with heavy forest, the deep spongy floor of which was much overgrown with knee- to hip-high bushes and rank grasses. The few cleared cultivated areas were knee-high in timothy and red-top grasses which were destined to provide feed for cattle during the long winter to come. Extensive searching in both of these areas proved to be almost impossible with the searcher's range of vision limited to but a few feet at a time. Search activities were therefore largely

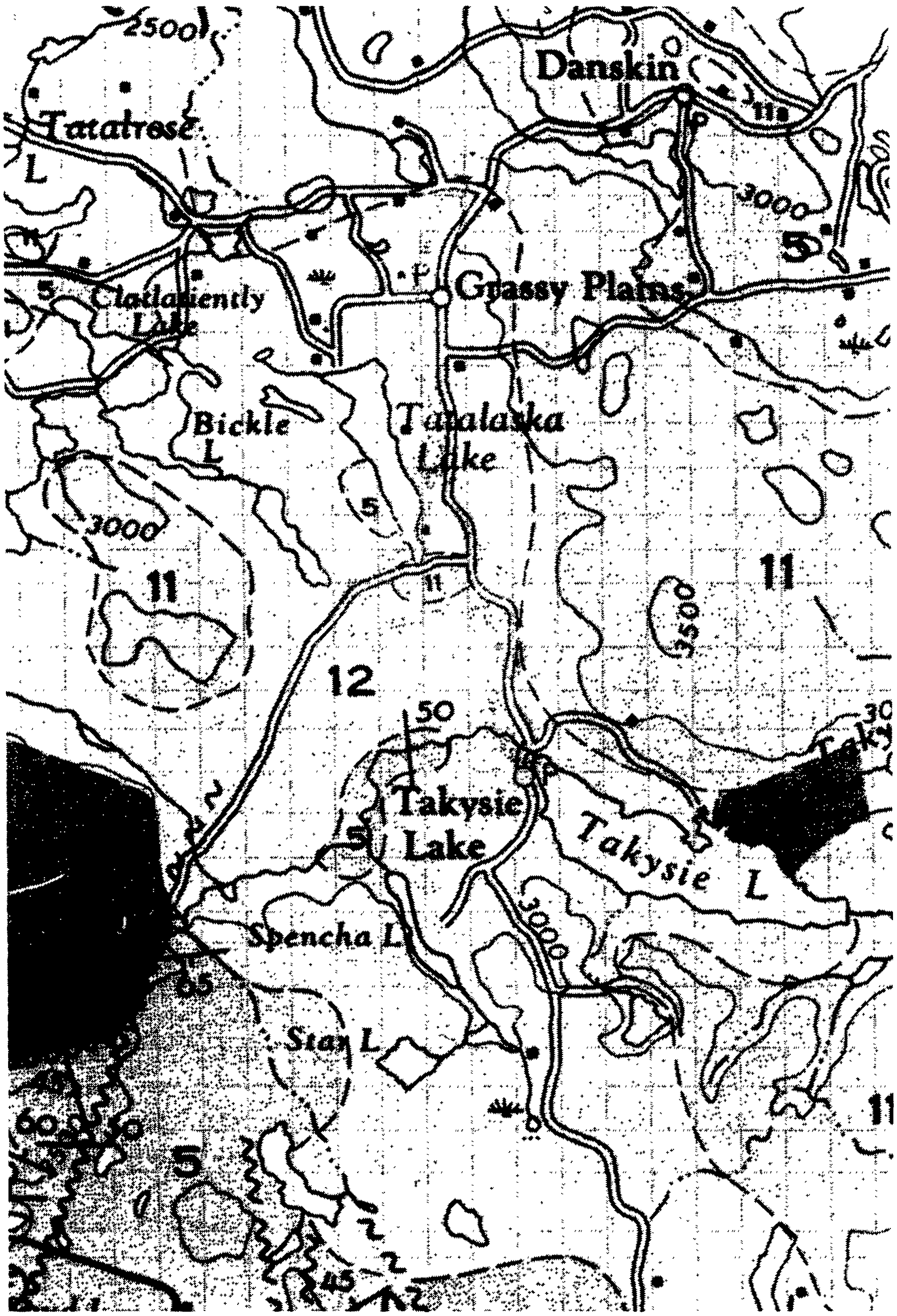

FIGURE 2—Area of search. 5) Middle and (?) Lower Jurassic, Hazelton Group (in Part): Andesite, related tuffs and breccias, chert pebble conglomerate, shale, and sandstone. 11) Tertiary. Miocene and (?) Later Endako Group: Vesicular and amygdaloidal andesite and basalt; flow breccia, tuff, conglomerate, greywacke, and lignite. 12) Quaternary. Pleistocene and recent: till, gravel sand, clay, and silt.

confined to the roadways and adjacent cleared areas and to the piles of stones under the fences surrounding the cultivated fields.

The first stone had been found about 800 feet west of the point where an east-west road connects to the north-south road leading from Burns Lake to Takysie Lake Village (Figure 3). The search began at this point and extended first to the west. For the first quarter of a mile, stones were quite numerous along the wide cleared right-of-way beside the road and in the stone piles under the fence beside it. Gradually they became more and more sparsely scattered until the last of 31 specimens was found approximately 0.6 mile from the corner. Area checks at 6, 7, and 14 miles along the west road proved fruitless. Three stones were turned up among the stones under the north-south fence at the west end of the cleared field which parallelled the road for one-half mile. Forest land which lay to the south of the road yielded nothing.

The search was carried out along the road to the south from the junction. Seven specimens were found at 300 feet, 800 feet, 1,100 feet, and 1,400 feet along the sides of this road and upon the clear sides of a hill adjacent to it. No specimens were found farther south although search was made to Takysie Lake Village three miles distant. It should, however, be noted that certain sections of the southward area could not be searched because of the terrain.

Northward from the junction three specimens were found on the west side of the road between the junction and an abandoned road which cut off to the west 800 feet north of the junction. Along this roadway, two specimens were found at approximately 950 feet and 1,000 feet west of the north-south road in the stone piles under the fence bounding the field on the north side of this old roadway. One small specimen was found along the roadway 1,100 feet north of the junction. Two more specimens were found at points 3 and 3.3 miles north of the junction. None of these specimens exceeded $1\frac{1}{2}$ pounds in weight.

All told, 55 specimens ranging in size from 12.5 grams (0.44 oz.) to 19 pounds 12 ounces with a total weight of 127.6 pounds were collected.

Although it was impossible to search much of the area which should be investigated, the distribution of the stones was not inconsistent with meteoritic distribution. Spot checks of areas three-fourths to one mile in length were made farther away from the site of find, but no stones even vaguely resembling those collected were found.

At the American Meteorite Laboratory in Denver five stones ranging in size from 18 pounds 6 ounces to 215 grams (7.58 oz.) were cut (Figure 4). Slices of these were sent to Ames Research Center for determination of the presence or absence of any evidence of exposure to cosmic radiation. The results of the gamma ray analysis, conducted by Robert C. Wrigley, NASA Research Scientist at Ames Research Center, were reported as follows:

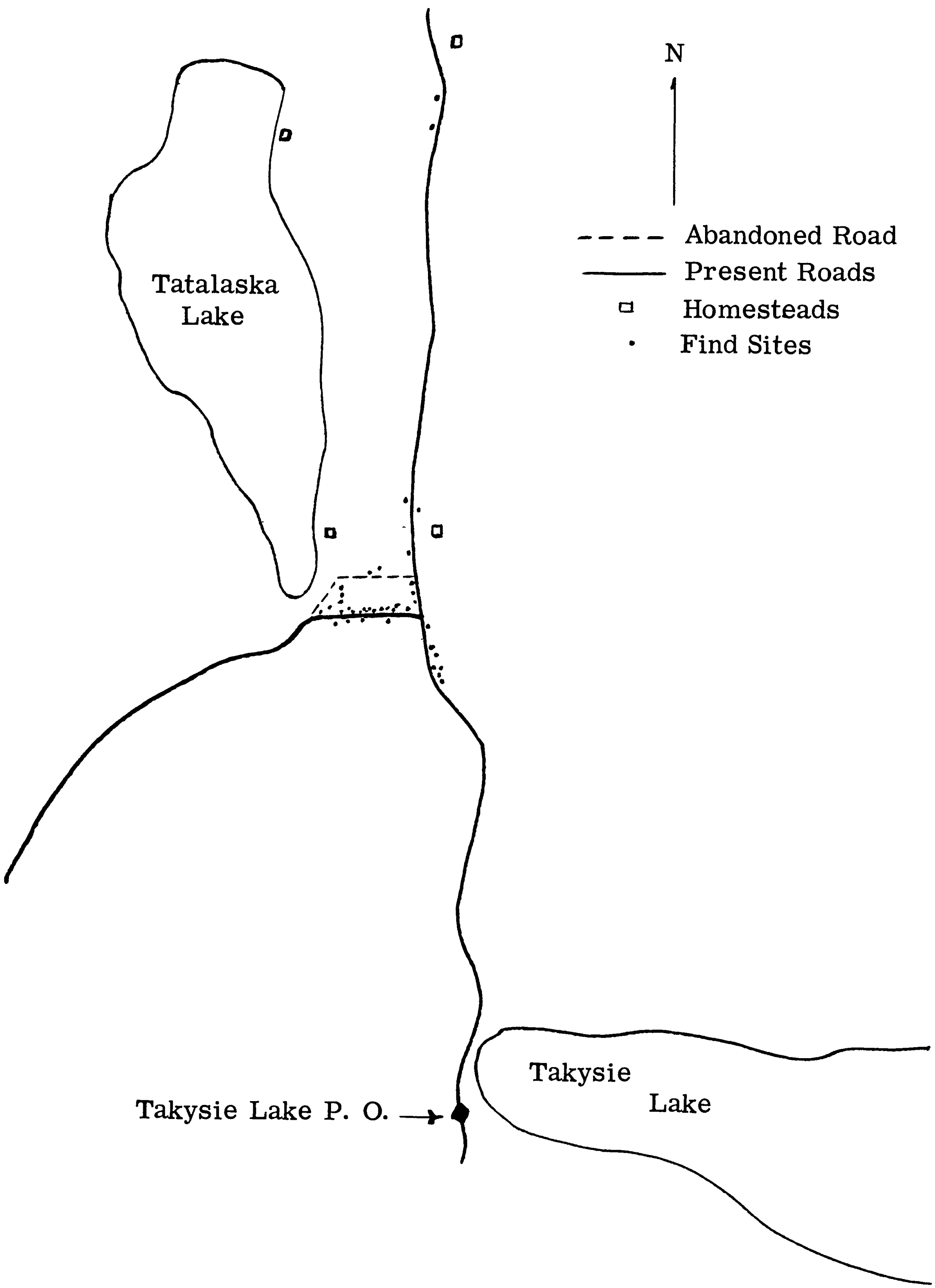

FIGURE 3—Location of strewn field.

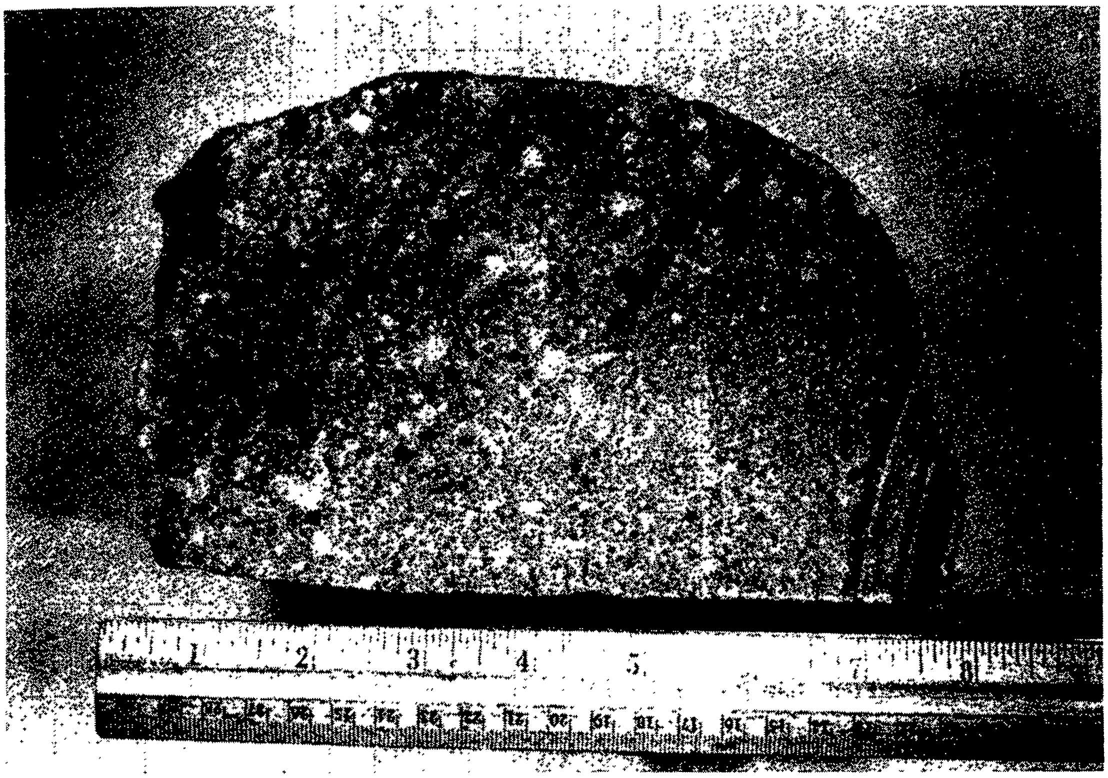

FIGURE 4—Cut face of an 18.5-pound stone.

Specimen	Mass	Counting Time	Al^{26} Content
2B	714 g	5,000 min	0 ± 0.6 dpm/KG
15B	200 g	1,000 min	0 ± 4.2 dpm/KG
18A	73 g	7,000 min	0 ± 3.7 dpm/KG

"No Al^{26} could be detected down to the level of Statistical fluctuations. The probable errors are quoted to define these fluctuations. The chondritic average concentration of Al^{26} is approximately 50 dpm/KG; achondrites tend to have somewhat higher concentrations. Hence, specimen 2B (which had the best possibility of revealing Al^{26} due to its size) contains no more than 1% of the expected amount, if any. The other specimens, 15B and 18A, contain less than 10% of the expected amount, if any."

Because of the number and size of the samples used, the above tests show that there is no justification for ascribing the low counts to shielding in space, although there is the remote possibility that with such an evident abundance of material the samples could have come from the center of a large parent meteorite. One researcher commented that it was as if these stones had been buried and only recently uncovered, because he would have expected more of a count than this in common earth surface rocks.

Petrographic studies conducted by Bevan M. French of the Geochemistry Laboratory, Laboratory for Theoretical Studies at Goddard Space Flight Center, brought the following report:

> " . . . the rock is an agglomeration of glassy material containing small crystallites, mixed in with fragments of crystals. The general texture strongly suggests the appearance of a basaltic tuff accumulated by the deposition of glassy fragments and crystals blown into the air from a volcanic vent. The crystals appear to be plagioclase feldspar, and some preliminary measurements on the extinction angles suggest an anorthite content in the range 40-60%, consistent with a basaltic or andesitic volcanic rock. Most of the glass does not seem devitrified, although occasional inclusions show oxidation, a brownish color, and a cloudy appearance; from this I would speculate: (1) that the material is of fairly recent age, and (2) that it was laid down in air rather than in water; water-laid basaltic tuffs show strong unusual devitrification effects in the glass, forming a striking red-brown material called palagonite."

Examination of a sample of crust material by Michael F. Sheridan, an Igneous Petrologist and Assistant Professor of Geology at Arizona State University, brough the following report:

> "I found the sample to be composed almost entirely of two types of glass particles, with a very minor amount of crystalline material. The first type of glass, and the most abundant, occurs as deep yellow equidimensional plates which display a weak irregular birefringence, indicating some secondary alteration. The refractive index of the majority of these particles is 1.515± .005, implying a silica content of between 63 and 68% according to the curve of W. O. George for natural glasses. This glass has much the appearance of palagonite or hydrated basaltic glass. The second type of glass is more rare, occurring as pinkish-white elongate shards. This glass has a higher refractive index of 1.535 ± .005, which suggests a SiO_2 content of 56-59%. Few grains were found to fall between these two values."

Thus we have a distinct group of stones with a somewhat tuffaceous structure which are scattered in the manner of meteorites over a discrete area of glacially deposited hills. Each of these stones is partially or completely covered with a glassy crust composed of an inhomogenous intermixture of two silicates common to the stones. The texture and structure of this crust is similar to that of stony meteorites. The outer portions of the stone show deterioration from recent weathering but none of the crustal material fills the pits formed by the weathering processes. This indicates that the crust was formed prior to the onset of decay and is consistent with the formation of crust on stones of meteoritic origin which suggests a space origin for these stones.

Although it has become customary to rely upon the presence of nickel-iron for establishing the identity of stony meteorites, it is well known that at least four meteorites (Chassigny, France; Shalka, India; Roda, Spain; and Angra dos Reis, Brazil) have been seen to fall which contained no nickel-iron. Identification in such cases is reduced to the presence of witnesses to the fall, isotopic content, or fusion crust. In the absence of witnesses, one must rely upon the latter two. But should an object come from a source as close to the earth as the moon, there would be no discernable isotopic content. There is, however, no known way for a meteorite, or secondary meteorite, to reach the earth's surface without having first been subjected to high-speed ablation and the formation of fusion crust. And conversely, there is no known way for nature to produce a thin fusion crust such as is borne by the Takysie Lake stones or known meteorites other than by aerial ablation. One proof of space origin should therefore be the presence of fusion crust.

The almost complete lack of radiogenic nucleides indicates that the stones had a short space history, if any, and that they may in fact have been buried until recently.

The color of the stones is a grayish brown. The August, 1966, issue of "Sky and Telescope" states that according to information sent back by Surveyor I, "The prevailing tone of the (Lunar) soil is a grayish brown."

Considering all of these facts together, we suggest that the Takysie Lake, British Columbia, stones are secondary meteorites which have been blasted from beneath the lunar surface and have fallen to the earth in the manner of meteorites in the not too distant past.

In order to establish the validity of this premise, further laboratory work should be undertaken, such as determining the condition of the stones relative to shock effects although their presence is not absolutely mandatory. Also fruitful would be further field work as follows:

1. Clear the underbrush, moss, and leaves from an area of approximately four acres south of the road adjacent to the known strewn field and search for more stones. Should the results so indicate, further clearing could be undertaken.

2. Search on foot and by helicopter for evidence of a small crater.

3. Show samples of these stones to all geologists who have worked in the general area, stressing the fusion crust. Should any recall seeing similar stones, encourage the submission of samples to be studied and compared with the present collection.