Minakami calculated the energies and pressures for a number of eruptions of Asama Volcano in Japan[4].

On March 30, 1956, a paroxysmal explosion of Bezymianny Volcano, Kamchatka, occurred. Gorshkov[5] determined the energy of this eruption from the seismic energy connected with the explosion, from the air wave of the blast, and from the equation here, each of which gave approximately the same value. Gas pressure at the time of the explosion was computed from Bernouilli's equation. Values were appreciably higher than for the Asama eruptions and it appeared that a relationship between energy and pressure might be found based on the Japanese and Russian data.

Values published by Minakami and Gorshkov are plotted in Fig. 1, in which is shown an eye-fitted linear relationship between the logarithm of kinetic energy and the logarithm of gas pressure. The equation of the relationship is:

$$E = 10^9 P^{4.2}$$

where energy is in ergs and pressure is in atmospheres or in bars.

Data used in Fig. 1 are few in number, and it would be very desirable for volcanologists to augment them to learn if the given relationship is valid throughout the range of pressures and energies associated with volcanic eruptions. While there are a number of reports on the energies of explosions, for example refs. 6 and 7, and the energy may be determined from barograms[8], the necessary observations needed to calculate pressures are lacking. It is hoped that this deficiency will soon be rectified.

This work was carried out in 1961 while I held a National Academy of Sciences—National Research Council post-doctoral resident research associateship at the U.S. Navy Electronics Laboratory in San Diego, California.

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## GEOLOGY

### Origin of Australites

THE problem of the origin of tektites, of australites in particular, has been a subject of speculation and controversy for many years. A great body of physical and chemical data on tektites is available and has been used to support various genetic arguments.

According to their present-day terrestrial manner of occurrence, tektites are geological material. Consequently, all their geological properties must be investigated. Physical and chemical data are not sufficient.

During my stay in Australia, I have been fortunate enough to examine the principal public and private australite collections. My investigation was undertaken in order to check the lithological homogeneity of australites, with particular reference to the presence of inclusions of material 'foreign' to them. The number of specimens which I examined totals more than 33,000 (see Table 1). The specimens were initially investigated by means of a 10-power magnifying glass. Any specimens suspected of containing 'foreign' material were put aside and eventually borrowed to be submitted to microscopic investigation. Thin sections were prepared and investigated of several specimens, but 'fingers'[1] were the only internal feature observed.

All the specimens available were checked. Thus, the material investigated consisted of fresh well-preserved specimens and water- and wind-worn corroded and abraded specimens, whole specimens and fragments, and large and small australites.

Table 1. SOURCES AND NUMBERS OF LITHOLOGICALLY INVESTIGATED AUSTRALITE SPECIMENS

| Source of material | No. of samples investigated |
|---|---|
| Australian Museum, Sydney | 398 |
| South Australian Museum, Adelaide | 19,308 |
| National Museum of Victoria, Melbourne | 1,621 |
| Western Australian Museum, Perth | 1,698 |
| University of Adelaide, Department of Geology and Mineralogy | 1,812 |
| University of Melbourne, Department of Geology and Mineralogy | 623 |
| University of Queensland, Department of Geology and Mineralogy | 248 |
| School of Mines of Western Australia, Kalgoorlie | 195 |
| Dr. George Baker, Melbourne, Vic., private collection | 2,958 |
| Mr. W. H. Cleverly, Kalgoorlie, W.A., private collection | 341 |
| Mr. Dale Tillotson, Kalgoorlie, W.A., private collection | 4,227 |
| Mr. C. B. C. Jones and Mr. John Jones, Hampton Hill Station, Kalgoorlie, W.A., private collection | 70 |
| Other sources (including Geological Survey, Hobart; Museum, Hobart; University of Western Australia; Queensland Museum) | 197 |
| Total | 33,696 |

The australite collection in the South Australian Museum is the largest public collection in existence. Mr. Tillotson's collection, in June, 1965, totalled about 5,300 specimens. The two collections could not be examined *in toto*, because many samples were being investigated by research workers in the United States. The Jones collection, derived mainly from the Hampton Hill Station area, according to a conservative estimate of the owners, totals about 10,500 specimens but may amount to 11,000 specimens. The 70 specimens investigated were selected at random.

During the course of the investigation I was unable to find any material foreign to australites even in a single specimen. Lithologically, the material was exceedingly homogeneous, even to the extent of being monotonous. I was particularly keen on trying to find inclusions of terrestrial sedimentary and igneous rocks, such as shale, sandstone and granite which, because of similarities in chemical composition, are believed by many to be the parent material of tektites; but all my efforts were in vain. Moreover, the museum curators and the owners of private collections assured me that they had never observed any 'foreign' material in australites. Consequently, adding to the 33,700-odd australites which I personally investigated another 1,000 specimens from the Tillotson collection (see Table 1) and the 10,500-odd specimens in the Jones collection (see Table 1), the conclusion follows that no 'foreign' material whatsoever has been observed in a total of about 45,200 australites. This sample certainly represents the majority of australites so far discovered, and the statistical probability of finding inclusions of terrestrial material in any other australite is extremely small. Finally, Chao[2] examined about 2,000 australites under the binocular microscope; his report does not mention the presence of 'foreign' matter in this material.

If the australites originated by an asteroid impact, a giant meteorite impact, or a comet impact on the Earth, as Urey[3], Barnes[1] and Cohen[4], among others, have suggested, then they, like genuine impactites[2,5], would be heterogeneous. I find it impossible to believe, on the basis of my lithological observations, that australites are terrestrial impactites. Their lithological homogeneity rules out terrestrial origin. The impact producing such a homogeneous material would certainly have been so violent and of such dimensions that several generations of trained geologists could not possibly have failed to observe other effects caused by such a tremendous catastrophe.

If australites formed by an impact on the Moon, their lithological properties suggest that the part of the Moon's surface in which they originated must have been very homogeneous indeed.

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