10. Characteristics of Deposits formed by Pumice Flows and Those by Ejected Pumice.*

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Introduction.

The eruption of Komaga-take, Hokkaidô, in 1929, brought to light two different ways in which pumice is deposited, one as the result of pumice flows, and the other as the result of showers of ejected pumice. These two kinds of pumice deposits have each their own distinctive characters, as seen in their surface features and in their internal structure. The Recent and Pleistocene pumice beds of Hakone, Huzi, Asama, and Haruna, all in central Japan, exhibit the same features as those of Komaga-take. This paper is an attempt to describe the observed differences in the two kinds of pumice beds that are specially responsible to their modes of deposition.

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The Pumice Deposits of Komaga-take.

During the eruption of this volcano in 1929, large quantities of andesitic pumice were ejected from the summit crater. Some of the pumiceous ejecta that was thrown high above the crater, was wafted by the wind and rained on the southeastern and eastern slopes of the cone, where they accumulated and formed extensive beds, while some that fell near the crater rim, without accumulating there owing to the steepness of the slope, rolled down the flank as pumice flows. Three major flows were recognized, namely, the northern, western, and southwestern, all of which spread into fans of pumiceous debris, widening

* Dedicated to the late Professor Mishio ISHIMOTO.

out toward the foot of the volcano.

These phenomena have been already described by previous authors who studied the activity of this volcano.[1]

At the time of the writer's visit to the volcano in September 1939, these pumice deposits were traversed by the numerous gullies that had formed during a decade of erosion, along the bottoms of which could be seen the pre-1929 ejecta. These exposures enabled the writer to examine cross sections of the pumice deposits. He studied the pumice beds that cover the southeastern slope, and also the deposits of the western and the southwestern pumice flows (the Osidasi-zawa or Osiranai pumice flow, and the Goban-zawa or Akaigawa pumice flow respectively).

Distinctive Characters of the Deposits.

(I) The surface of the deposits formed by the ejected pumice is quite even throughout (Fig. 1), the minor undulations of the old topography having been smoothed out by accumulation of the pumice. In contrast to this, the surface of the debris of the pumice flows is greatly undulated;[2] a number of primary grooves and ridges being developed parallel to the direction of flow (Figs. 4, 5, and 6). The ridges, which usually stand from about 0·5 to 1 m above the bottom of the grooves, consist largely of coarse fragments (Figs. 4, 5, and 6),—a feature recalling the surface of the debris of some snow avalanches.

(II) The ejected pumice was accumulated so extensively that all traces of the pre-existing topography were erased, only the precipitous slopes escaping the mantle of the pumice. In the case of the pumice flows, however, the tendency to stream down along the lower parts of the pre-existing topography was so strong that even the small ridges and hills of the older lavas and ejecta stand above the surface of the flows. The pumice flows that came to cliffs simply cascaded down them.

(III) The variation in grain-size of the pumice fragments with distance from the crater is a feature that is not likely to be overlooked by any observer who traverses the devastated area of Komaga-take. In the deposits formed by the ejected pumice, the size of the pumice fragments increases as one approaches the crater. Thus, at Sin-ogawa, 6 km southeast of the crater, the average size of the grains is some-

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1) H. TSUYA, *B. E. R. I.*, **8** (1930), 238~270.
S. KÔZU, *Tscherm. Min. Petr. Mitt.*, **45** (1934), 133~174.

2) On account of this feature, the areas covered by the debris of the pumice flows make walking difficult, in contrast to that covered by the ejected pumice, where the walking is easy.

what less than 10 cm (Fig. 2), near the triangulation point 244·8 m high, 4 km southeast of the crater, it is about 10 cm, and at an elevation of 500 m, 2 km eastsoutheast of the crater, it is about 30 cm. Moreover, within limited areas, the grain-size is fairly uniform, laterally and vertically. In the pumice flows, on the contrary, scarcely any regularity is to be noted in the variation in grain-size with distance from the crater, nor is there any uniformity in grain-size within limited areas. A distinct tendency is however noted for the coarser fragments to concentrate in the narrow ridges, as already mentioned, and also toward the end of each flow, where it often terminates in a steep front just as in the cases of certain block lavas and avalanche debris. Thus, at the end of the Osidasi-zawa pumice flow, 4 km northwest of the crater, pumice fragments 0·5~0·3 m large were found almost to the exclusion of finer grains. Such contrast is best seen along the east-west trail in the southern flank of the cone, which crosses the boundary that separates the two different deposits 4 km distant from the crater.

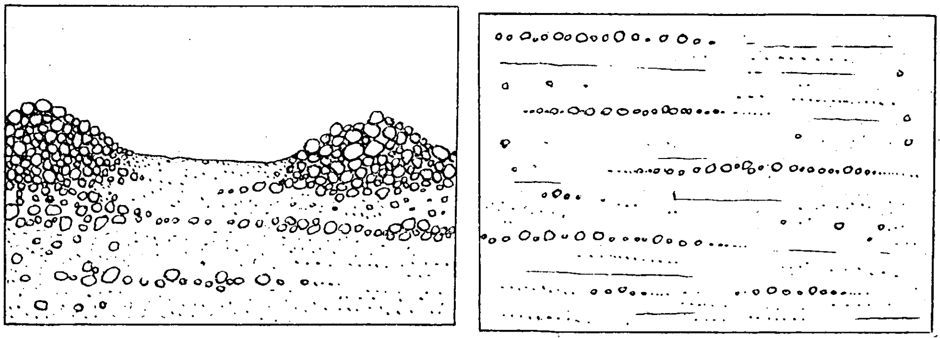
(IV) The variation in thickness of the deposits with distance from the crater runs somewhat parallel to the variation in grain-size just mentioned. The thickness of the deposits formed by the ejected pumice gradually increases as one approaches the crater. Thus, at Sin-ogawa, the general thickness is about 0·3 m, while it becomes about 0·5 m near the triangulation point, 244·8 m high; and about 2 m at an elevation of 500 m. In the pumice flows, however, the maximum thickness is attained at a certain point near the end of each flow, and also just below the cliffs of the older rocks over which the pumice flows cascaded. The maximum thickness of the Goban-zawa pumice flow is at least 2 m, while that of the Osidasi-zawa flow is about 4 m.

(V) The virtual absence or paucity of the finer particles that cement the coarser fragments, is one of the characteristics of the deposits formed by the ejected pumice. The interstices between the fragments are usually empty spaces without any filling of foreign matter (Fig. 2). In the pumice flows, on the other hand, there are abundant fine particles that cement the coarser fragments, except at the tops of the flows (Figs. 3, 4, and 6), and also in some distinct zones, along which the coarser fragments are concentrated. The cement is always the finely divided particles of the pumice itself, usually of sand size. The proportion of this cement varies greatly in different layers within a flow (Fig. 6), some layers being made up almost exclusively of fine particles.

The most probable explanation of this contrast in feature is that, in the pumice flows, a large quantity of fine particles were formed by attrition of the pumice fragments as they rolled down the flank, while in the ejected pumice, sorting of the grain by size was accomplished so completely during its flight through the air that the finer particles, if they were present, were transported for longer distances from the crater than the coarser fragments.

However, this distinctive character is not evident in the vicinity of the crater, because the ejected pumice that accumulated there was mixed wth a large proportion of fine particles.

(VI) The way in which the deposits are stratified differs markedly with their modes of origin. The deposits formed by the ejected pumice show regular stratification according to slight differences in size of the fragments in different layers. The strata continue fairly even as far as they are visible from any particular point. In great contrast to this is the irregular and indistinct stratification one sees in the deposits of the pumice flows. Generally speaking, they show a chaotic structure owing to the haphazard mixture of fragments varying widely in size (Fig. 6). Any particular layer is always interrupted when traced laterally for some distance. Again, some of the layers, consisting of more or less uniformly sized fragments, either thin out laterally or pass into an unstratified mass because of intermixture of fragments of different size (Fig. 7 a). However, some layers, which are chiefly made up of finely divided particles, contain somewhat coarser fragments arranged in ill-defined zones parallel to the general bedding (Fig. 7 b). It is not-



a b

Fig. 7. Cross sections of the deposits of the pumice flows of Komaga-take.

able that lenticular masses or bands, consisting largely of accessory fragments of compact andesite, are often intercalated between the deposits—a feature entirely lacking in the deposits of the ejected pumice.

The origin of the structures of these pumice flow deposits above described may be attributed to differential movements of a number of streams within each pumice flow, overlapping one another or merging the one into the other. Obviously, the differential movements are the result of differences in the grain-size of the components that formed the pumice flows. The coarser fragments, which moved faster than the finer, were collected together to form narrow streams that deposited in the form of ridges (see p. 145). The accessory fragments, which form the lenticular masses already mentioned, were probably torn away from the bed-rocks that were exposed along the courses of the pumice flows.

Pumice Deposits of Hakone, Huzi, Asama, and Haruna.

In Hakone volcano, there are deposits which are believed to have been formed by pumice flows[3] (Fig. 8). These deposits, which are of Younger Pleistocene age, have much greater lateral and vertical extensions than those of Komaga-take. Deposits which are inferred as having been formed by ejected pumice are also found here.

In the adjacent Huzi volcano, lying northwest of Hakone, dacite pumice and basalt scoriae were ejected from the Hôei explosion crater in 1707,[4] a new crater that opened at the time on the southeastern flank of the cone. These ejecta rained on the eastern area. The regularly bedded deposits, consisting of dacite pumice at the base and basalt scoriae at the top, are extensively developed from the southern part of the Tanzawa Mountainland to the northern flank of Hakone.

Excellent examples of deposits formed by ejected pumice are also found in the Asama and Haruna volcanoes. In the former volcano, andesitic pumice that was ejected in 1783 from the summit crater,[5] accumulated on the mountainous land east of the cone. The deposits are well observed at various points to the north of the town of Karuisawa (Figs. 9 and 10). In the latter volcano, which lies about 30 km eastnortheast of the former, dacitic pumice was ejected from the crater that opened in the eastern part of the cone at a relatively younger period of its history[6] (probably Holocene). These deposits, which covered the eastern half of the volcano, are seen well developed around the town of Ikaho.

Although the surface features of the pumice deposits of these volcanoes are somewhat obliterated by weathering and vegetation, their internal structures can be studied from a number of exposed sections.

3) Inferred from the distribution of the deposits and their relation to the underlying topography. H. KUNO: *Jour. Geol. Soc. Japan*, 45 (1938), 493; *Proc. 6 th Pacific Science Congress.* (California), 1939, 875.

4) Oral communication by H. TSUYA.

5) H. TSUYA, *Geography* (Tirigaku), 2 (1934), 25.

6) S. TANEDA, a paper read before the 47 th annual meeting of the Geological Society of Japan, 1940.

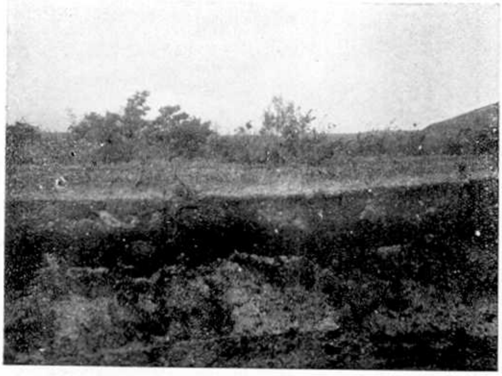


Fig. 1. Cross section of a deposit of ejected pumice. The eastern flank of Komaga-take.

Fig. 2. Cross section of a deposit of ejected pumice. Near Sin-ogawa, the southeastern foot of Komaga-take.

Fig. 3. Cross section of a deposit of pumice flow. Goban-zawa, the southwestern flank of Komaga-take.

Fig. 4. The surface of a deposit of pumice flow. Goban-zawa, the southwestern flank of Komaga-take.

Fig. 5. The surface of a deposit of pumice flow. Goban-zawa, the southwestern flank of Komaga-take.

Fig. 6. Cross section of a deposit of pumice flow. Osidasi-zawa, the western flank of Komaga-take.

Fig. 8. Cross section of a deposit of pumice flow. South of Yamakita-mati, northeastern foot of Hakone.

Fig. 9. Cross section of a deposit of ejected pumice (1783). Near Kose, east of Asama.

Fig. 10. Cross section of a deposit of ejected pumice (1783). Near Kose, east of Asama.

The structural similarity of the pumice flow deposits of Hakone to those of Komaga-take, and that of the deposits of the ejected pumice of Hakone, Huzi, Asama, and Haruna to those of Komaga-take are so marked that there is no need to describe the deposits of these central Japanese volcanoes.

Conclusion.

Based on observations of the Komaga-take volcano, the distinctive characters of the deposits of the pumice flows and those formed by the ejected pumice that rained on the ground are described ((I)～(VI), pp. 145～147). These distinctive characters are explained as the results of the particular ways in which they were deposited. The deposits formed by pumice flows and those by ejected pumice of some volcanoes in central Japan exhibit the same contrast in features that exists between the two different kinds of deposits of Komagatake. These characteristics form useful criteria for determining the mode of deposition of some pumice deposits. For deposits that are either only partly preserved or are somewhat disturbed, as may occur in those of Tertiary and still older ages, the characteristics described in (V) and (VI) appear to be especially useful in distinguishing their mode of deposition.

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10. 輕石流堆積物と抛出輕石堆積物との差異に就いて

地質學教室 久 野 久

昭和4年北海道駒ケ岳火山噴火の際，抛出された輕石の一部は風で運ばれて，火山體の東南斜面に廣く堆積し，他の一部は北方・西方・西南方に斜面を流下して輕石流を形成し，火山體の麓に扇狀の堆積物を生じた．之等2種の堆積物の各々には，その表面の性質並びに內部構造に於いて明瞭な差異が認められる．之等の差異は其等堆積物の堆積機構の相異によつて生じたものと說明される．

箱根・富士・淺間・榛名等の諸火山の輕石堆積物も，駒ケ岳に於けるものと全く同樣な性質を有する．此等の特徵に基けば，或種の輕石層の堆積機構を推定する事も可能である．
