CRUSTAL AND SUBCRUSTAL NODULES IN EJECTA FROM KILBOURNE HOLE MAAR, NEW MEXICO.

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Nodules retrieved from the ejecta of volcanic craters serve as the source of two major items of information. The first is in providing details of the geochemistry and mineralogy of the Earth's interior by supplying samples of materials that cannot be obtained by existing drilling techniques. The other is in providing information regarding the process which led to their transport from the Earth's interior to the surface.

Kilbourne Hole is one of several maars located in southeast New Mexico (Hoffer, 1976). It is elongate, approximately 3 km long and 2.5 km wide and nearly 100 m deep. The age of the maar is not well constrained. A basalt underlying the maar ejecta has yielded K-Ar whole rock ages of 141 $\pm$ 75,000 years and 103,000 $\pm$ 84,000 years. The remains of a ground sloth found in a fumarole of the nearby younger Aden lava cone are dated at 11,000 years (De Hon, 1965). The xenoliths are found within the eruptive breccia which immediately overlies the Afton Basalt flow. The breccia ranges in thickness from 15.25 m thick on the northern rim of the crater and is thin to absent on the southern rim.

The primary purpose of the present study was to examine the morphology of the nodules in an attempt to place some constraints on the process that brought them to the surface. The spinel-lherzolites and garnet-granulites from Kilbourne Hole have been the object of several geochemical studies (Padovani and Carter, 1977; Basaltic Volcanism Study Project, 1980; Irving, 1980; Padovani and Hart, 1981; Feigenson, 1986). It is not unfair to assume that the authors of those articles, and other unnamed persons, have removed a quantity of the "better" and probably larger nodules from the maar. At the other extreme, the small (less than 2 cm diameter) nodules are invariably totally enclosed by a rind of alkali basalt and are not obvious until the rock is broken open. Once the rock is broken, it is then difficult (in the field) to determine the dimensions of the nodules. The study was therefore somewhat biased in that it ignores the small nodules and is probably underrepresentative of the bigger nodules.

The primary targets for the present analysis were the spinel-lherzolite nodules since these are readily identifiable because of their color contrast with the enclosing lava and because they invariably still have a protective enveloping basaltic rind. This olivine and pyroxene phenocrystic and vesicular rind varies from less than 1 mm to about 1 cm in thickness and forms a sharp contact with the enclosed nodule.

Figure 1 presents a summary of the axial length data for over 250 nodules collected at Kilbourne Hole. Although some nodules were recovered with lengths in excess of 25 cm, the majority have long axes of about 8 cm. This distribution appears to be similar to that obtained at other maars by McGetchin and Ulrich (1973). A feature which emerged from this study is that the nodules are not circular. A straight line fit through the data on figure 1 results in an approximate value of short axis equals 0.6 times the long axis length. This observation is important since departures from sphericity of the nodules result in changes in its drag coefficient (e.g., Komar and Reimers, 1978) - a parameter involved in the calculation of minimum flow rates.

A second feature to emerge from the study is the wide range in size of the nodules from less than 1 cm to in excess of 25 cm. The majority (68%) of the nodules, however, have long axes between 5 and 10 cm in length. Further study is needed to determine if these values reflect the initial sizes of the nodules at their point of origin, sorting and collisional effects on the way to the surface, or sorting effects within the ejecta blanket.

Dimensional and density data for representative samples of the nodules plus their basaltic rinds are presented in table 1.

| Rock Type | Weight (grms) | Volume ($cm^3$) | Density ($kg/m^3$) |
|---|---|---|---|
| Pyroxenite | 1786 | 570 | 3133 |
| Spinel-lherzolite | 609.5 | 198 | 3078 |
| Gneiss | 7200 | 2935 | 2453 |

Table 1:

References:

Basaltic Volcanism Study Project, 1980, Basaltic Volcanism on the Terrestrial Planets, Pergamon Press, N.Y. 1289 pp.

De Hon, R. 1965, Maare of La Mesa. New Mexico Geol. Soc. Guide Book, 15th Field Conf. p.204-209.

Feigenson, M.D., 1986, Continental alkali basalts as mixtures of kimberlite and depleted mantle: evidence from Kilbourne Hole Maar, New Mexico. Geophys. Res. Letters 13, 965-968.

Hoffer, J.M., 1976, Geology of the Potrillo Basalt Field, South-Central New Mexico. New Mexico Bur. Mines & Min. Res. Circular 149, 30 p.

Irving, A.J., 1980, Petrology and geochemistry of composite ultramafic xenoliths in alkali basalts and implications for magmatic processes withinn the mantle. Amer. J. Sci. 280-A, 389-426.

Komar, P.D., and Reimer, C.E., 1978, Grain shape effects on settling rates. J. of Geol. 86, 193-209.

McGetchin, T.R., and Ullrich, G.W., 1973, Xenoliths in maars and diatremes with inferences for the Moon, Mars, and Venus. J. Geophys. Res. 78, 1833-1853.

Padovani, E.R., and Carter, J.L., 1977, Non-equilibrium partial fusion due to decompression and thermal effects in crustal xenoliths. State of Oregon Dept. of Geol. & Min. Ind. Bulletin 96, Magma Genesis. p.43-57.

Padovani, E.R. and Hart, S.R., 1981, Geochemical constraints on the evolution of the lower crust beneath the Rio Grande Rift. Conf. on the Process of Planetary Rifting. Lunar and Planetary Institute, Houston, TX. p. 149-152.

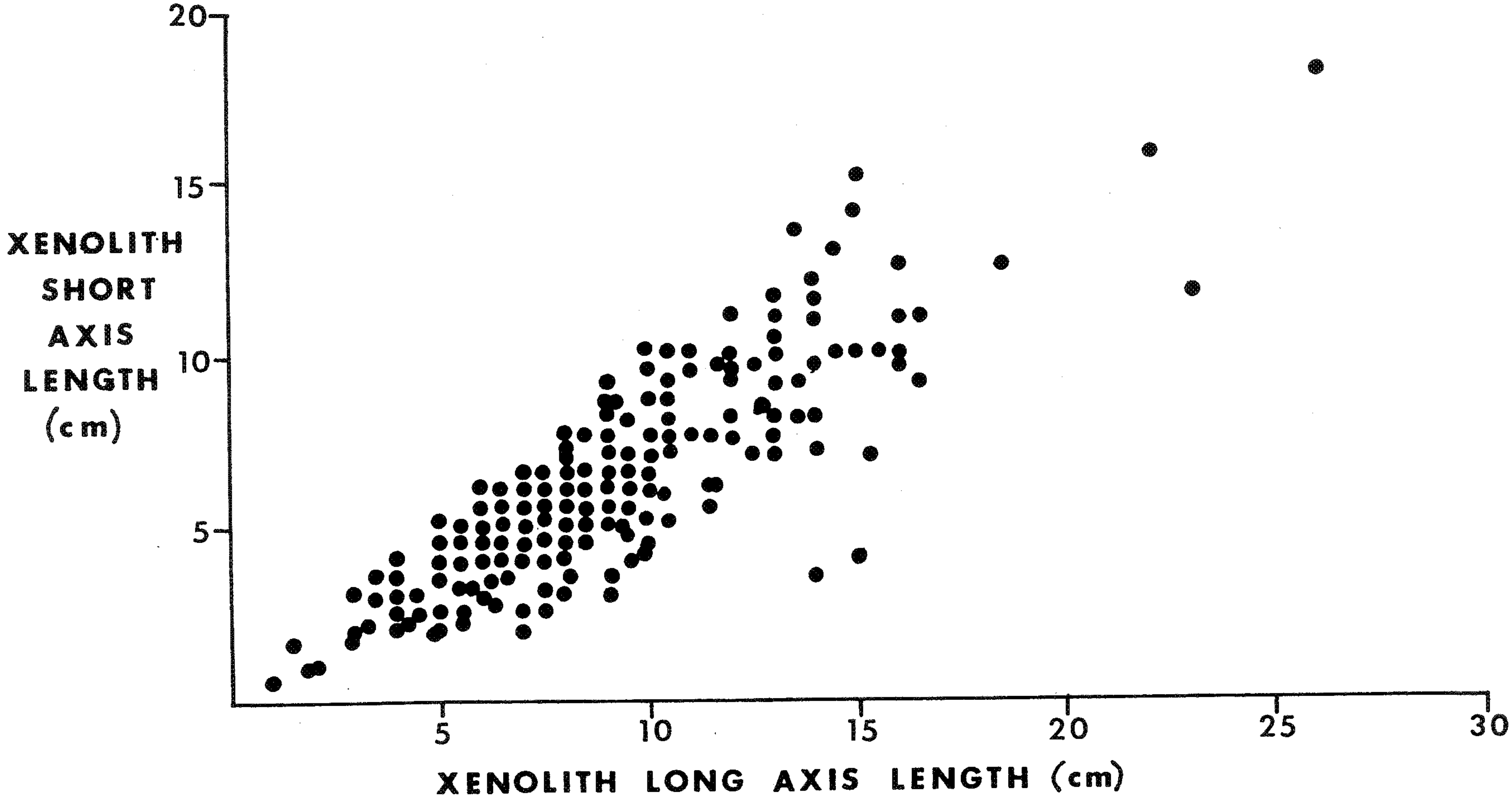


Figure 1: Axial lengths of nodules from Kilbourne Hole maar, New Mexico.