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PARENT SOURCES OF ANTARCTIC METEORITES AS INFERRED FROM PAIRING OF THE SPECIMENS.

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In the biginning of our Antarctic meteorite research, we thought that the Antarctic meteorites will provide us with good statistics on populations for different classes of meteorites. It is unclear, however, to estimate the number of different meteorites represented by the Antarctic collection, because some of them are paired. In addition, the number of Antarctic meteorites with unusual compostions or textures within a known class appears to be greater than what we expected from the non-Antarctic collections. It is natural to find rare, unique or unknown types, because the total number of specimen is large. We found, however, more anomalous ones in some classes of meteorite than the others. For example, all Yamato diogenites are different from the non-Antarctic diogenites in texture or chemical compositions (1) (2). Polymict eucrites are more abundant than howardites in the Antarctic achondrites (3) (4).

Among several answers to the question of why polymict eucrites or other unique meteorites are common in Antarctica, there is an evidence to support an idea that the meteorites on a specific ice field may represent falls in the local area during a certain period in the past and that the distribution of achondrite meteorites reaching the earth might have changed with time and the Antarctic collection represents an average over a much longer time interval or during a certain period in the distant past (4). Old terrestrial age of the Antarctic meteorites and differences betweeen the Yamato and Victoria Land collections are in favor of the hypothesis (5) (6). Even in more common meteorites, Antarctic and non-Antarctic meteorite may differ (7). They interpret these differences as reflecting derivation of Antarctic meteorites predominantly from parent sources or regions different than those from which contemporary falls derive.

Because it is expected that impacts or collisions of their parent bodies may produce fragments from different parts to have different orbits, the Antarctic meteorites may sample some portions of their parent body unknown from the contemporary non-Antarctic meteorites. If so, this characteristics of the Antarctic meteorites will greatly help us to reconstruct the parent body or mass for genetically related meteorites. To obtain a better understanding of the parent sources and their relation to asteroids, we reinvestigated several Antarctic achondrites and unique chondrites with electron microprobe and single crystal X ray diffraction and performed synthesis of their parent body for three classes of meteorites on the basis of pairing of the specimens.

(1) HED (Howardites, Eucrites, Diogenites) Parent Body. Discoveries of many polymict eucrites and the most diogenite-rich howardite, Y7308 from Antarctica, helped us to reconstruct their parent body (9). The polymict eucrites are regolith breccias produced by impacts of small bodies, which destructed, mixed and excavated only surface portions of the layered crust (9). The presence of unique clasts (4) and the same terrestrial age (6) suggested that Y74450, Y75011, Y75015, Y790007, Y790020 are paired. The basaltic clasts contain chemically zoned pyroxenes (4) and represent a extruded surface lava, framents of which were icorporated into cool regolith by a small impact.

Y7308 is a howardite rich in deep seated components such as Mg-rich orthopyroxene, and therefore it must be produced by a large scale impact, which may be comparable to lunar Mare Imbrium or Caloris Basin of Mercury.

This model of the parent body promoted the discovery of a diogenitic spot in eucritic mare regions on 4Vesta by rotational observation of the reflectance spectra (10). The petrologic study of Y7308 by Ikeda and Takeda (11) favors the fractional crystallization model to produce the layered crust(9). Other paired Yamato howardrites, Y790727, Y791208 and Y791492 differ from Y7308 because they contain less diogenitic components than Y7308.

The Y75032-type achondrites fill the compositional gap between diogenites and the cumulate eucrites, and show chemical and mineralogical characteristics intermediate between them in all respects (2). The Y75032-type achondrites sampled a transitional zone from diogenitic orthopyroxene and low-Ca inverted pigeonite and to cumulate eucrites in a trend of the fractional crystallization (12). Y791073, Y791200, and Y791201 contain more cumulate eucrite components. The unique mineralogy and texture suggested that this transitional achondrites are paired and came from a restricted region of the layered crust (9). Yamato 74013-type diogenites including 29 specimens show shock recrystallized textures indicating that they are pieces of a single fall (1). They may have been derived from beneath crater floor, where relatively slow cooling after shock heating produced such texture. All Yamato diogenites are different from the non-Antarctic ones.

Our recent study of rare Antarctic monomict eucrites, Y791186 and Y792510 and a crystalline clast in Y790266, indicates that they are similar to the non-Antarctic ordinary eucrites, but they differ texturally and chemically. Y790266 is a shocked clast-rich eucrite with a special chemical zoning of pyroxene with almost constant Mg concentration. Because non-Antarctic monomict eucrites are products of thermal annealing at or near the crater floor or wall by an impact according to cratering mechanics (12), we interpret that the trend of Y790266 is an intermediate in the course of homogenization. Remnants of the Mg-rich core of the originally zoned pyroxene found both in Y790266 and Y791186 support the above hypothesis. The fact that Y791186 and Y792510 were almost completely homogenized but still the original chemical zoning can be traced, may suggest pairing, but other data are required to be sure of this suggestion. In the old layered crust model of parent body of the HED achondrites, the ordinary eucrites were placed between the lava eucrite and cumulate eucrite layer (19). The present model prefers that many ordinary eucrites with clouding of pyroxene and plagioclase may be placed at a crater floor and wall (12), and that thickness of this layer may be thinner than that proposed previously.

(2) Ureilite Parent Body. Discoveries of Antarctic ureilites have almost doubled the numbers of meteorite samples in the ureilite group. Each of them showed some characteristic features, and are believed to be all different falls. This situation is in real contrast with the Antarctic HED achondrites, in which many of them are pieces of the same fall (1) (4). The range of chemical compositions of olivines and pyroxenes from the Antarctic ureilites extended both towards the Mg-rich, Fe-rich and Ca-rich sides. The Fa contents of the core olivines expanded from 14 - 22 Atomic % to 8 - 24 Atomic %. A similar trend was found in single pigeonite crystal showing clouding from Y790981 and ALH81101, which show strong shock textures.

The wider range of the Fe/(Mg + Fe) ratios in pyroxene now available from the Antarctic ureilites enabled us to test systematic variations of other elements with respect to the Fe/(Mg + Fe) ratios. Our plot of MnO/FeO ratio revealed weak anti-corelation as was found for chondrites (13). This anti-corelation is the result of reequilibration in the solid state with little melt when the metal-silicate equilibrium is involved. The oxidation

-reduction is an important process to produce a suite of ureilites. Little evidence of the presence of a planetary crust or layered structure for the ureilite parent body has been found.

(3) LL Chondrite Parent Body. Among the chondrite classes, the LL chondrites preserve records of surface processes taken place on a planetary body. Chondritic vesicular melt breccias (e.g. Y790964) revealed shock partial melting and rapid cooling at near surface condition (14). Much slower cooling of a similar partially molten breccias may produce achondritic LL chondrites such as Y74160 (13). Mineralogical study of Y791067, which is similar to Y74160, indicates that it contains more olivine and more homogeneous plagioclase than those of Y74160. Removal of shock produced partial melt from LL chondrites and much slower cooling may produce Y791067.

In summary, the above difference may suggest that the Antarctic meteorites may have been derived from regions different than those from which contemporary falls derive. If so, they are useful in reconstruction of their parent bodies or masses. However we have to admit that the difference may be an artifact produced by inadequate sampling. The discovery of a Vesta-like surface materials on near earth asteroid, 1915 Quetzalcoatl (15) suggests that fragments from different portions of it may be delivered to earth in different time sequence.

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