Sears D.W.G. (1990b) Summary of sessions A and B, Workshop on differences between Antarctic and non-Antarctic meteorites. *LPI Tech. Rept. 90-01*, 9-10. Lunar and Planetary Institute, Houston TX.

SESSION A
CHEMISTRY AND PETROLOGY
and
SESSION B
EFFECTS OF WEATHERING AND TL

Summarized by D. W. G. Sears

Those who spoke during the sessions, both during presentations and discussions, universally accepted that there were differences between the meteorites collected in the Antarctic and those collected elsewhere in the world. However, the significance of these differences was not obvious, and two questions repeatedly emerged whenever the interpretation of these differences was addressed. One of these questions concerned the effect of weathering. No one at the meeting felt that the present system of "weathering category" (A-C) was sufficiently sophisticated for scientific studies of weathering effects, although it does constitute a reasonable record of the curators' observations based on the hand specimens.

The other question concerned the amount of pairing present in the Antarctic meteorite collection. This question arose whenever distributions of a statistical nature were discussed, especially in connection with the extraordinary number of rare and unusual meteorites in the Antarctic collections. M. Lipschutz reviewed a wide variety of data that display differences between Antarctic and non-Antarctic meteorites. In particular, Lipschutz described the statistical analyses he and S. Samuels have made of 13 minor and trace elements. In a typical run, they have found that four or five elements differ significantly when Antarctic and non-Antarctic meteorites are compared. Lipschutz argued that these differences are not due to weathering but rather indicate that the source of meteorites reaching Earth has changed since the Antarctic meteorites fell.

E. Jarosewich also found differences in the composition of chondrites between Antarctic meteorites and non-Antarctic meteorite finds, with the latter being lower in Fe, Na, and S and higher in water. However, since non-Antarctic finds are in some cases intermediate to the previous two groups, he concludes that those compositional differences reflect weathering. Jarosewich also pointed out that there was no correlation between the alteration indicated by bulk chemistry and weathering category.

D. Mittlefehldt (with M. M. Lindstrom) described rare earth element data for eucrites and showed that Antarctic eucrites were not only depleted in REE with respect to non-Antarctic eucrites but also showed positive Eu anomalies and both positive and negative Ce anomalies. This is readily interpreted in terms of leaching out REE during weathering, but with much of the Eu not being leached out because it is located in plagioclase. The Ce is suggested to be oxidized to +4 and fractionated relative to the +3 REE. However, the process is more complicated than this. Mittlefehldt also found that even in interior chips from little-weathered stones Ce can be either enriched or depleted with respect to non-Antarctic eucrites. Another significant difference between Antarctic and non-Antarctic eucrites was described by Mittlefehldt, namely that Se is always considerably enriched in Antarctic eucrites.

M. Velbel identified five or six processes that occur during weathering, of which only one or two are represented in the weathering category (oxidation and hydration). Other processes may be even more important, such as those (solution and chelation) that result in the appearance of evaporites on meteorite surfaces. As with bulk composition, there is no correlation between weathering category and the appearance of evaporites. Some major and trace elements are likely to be mobilized (leached) during weathering.

The complexity of the weathering process was further demonstrated by V. Buchwald, who described six commonly found oxides or hydroxides of iron that are weathering products, including akaganeite (β FeOOH). This mineral is produced by a process catalyzed by Cl and occurs in the solid state at subzero temperatures, quite unlike conventional views of "weathering" that involve fluids. There is a sufficient supply of Cl in the Antarctic environment (e.g., snow and ice introduced from marine sources) leading to the formation of akaganeite with up to 5 wt.% Cl.

D. Sears ascribed the threefold difference in TL sensitivity between Antarctic and non-Antarctic H chondrites to weathering, even though TL sensitivity did not correlate with weathering category. He argued that the TL was probably affected by smaller levels of weathering than would significantly affect the appearance of the hand specimen.

K. Nishiizumi described measurements that explored the possibility that weathering affected terrestrial age measurements based on cosmogenic isotopes. Terrestrial age differences between collection sites and, in one case, from one end of a site to the other, have considerable implications for concentration mechanisms. However, since metal and silicate separates gave the same results, suggesting no redistribution of isotopes, and since this was true of all the meteorite classes, he was confident that his terrestrial age data were reliable. Nishiizumi suggested that the influx of different classes of meteorites relative to each other may change with time if the measured age frequency distribution is real. However, more terrestrial ages of meteorites are necessary to support this suggestion.

Two new methods of terrestrial age determination were described by N. Bhandari in a related poster paper in Session C, one involving the use of three cosmogenic isotopes whose activities show little depth dependence and one involving the measurement of TL buildup in and near the fusion crust. As mentioned above, pairing might explain a number of differences between Antarctic and non-Antarctic meteorites when the data are of statistical significance. The difference between Antarctic and non-Antarctic H chondrites in the temperature-width data of their induced TL peaks described by D. Sears is a case in point. If there is considerable pairing between the Antarctic meteorites studied, then the data would suggest that there are just one or two meteorites with an unusual postmetamorphic history, and not the whole Antarctic population.

Similarly, K. Nishiizumi observed that the terrestrial age distribution he reported could be seriously affected if there were significant pairing among his samples. The anomalously large number of rare and unusual meteorites in the Antarctic collection might also be less "anomalous" if considerable pairing occurs.

H. Takeda pointed out that the 27 Yamato diogenites are actually from only 2 separate falls and that at least 9 of the 27 polymict eucrites from the Antarctic are paired, as are 3 of the 5 Yamato lunar meteorites. He further described some Antarctic ureilites that are unlike non-Antarctic ureilites. Takeda showed that there are textural and chemical differences between Antarctic and non-Antarctic monomict eucrites, and that there is an overabundance of polymict eucrites in the Antarctic collection. He also stated that Antarctic diogenites are distinctly different from non-Antarctic ones, and reported the discovery of Antarctic HEDs that fill the compositional gap between diogenites and cumulate eucrites.

Most of the Antarctic C2 chondrites have extremely low cosmic-ray exposure ages (<200,000 yr), which may also indicate considerable pairing. However, U. Herpers and his colleagues, in a related poster paper in Session C, urge caution in pairing all of these meteorites since the Al-26 and Be-10 activities they reported at the meeting are so variable. It remains true, however, that a great many types of meteorites are found in the Antarctic collection that are not found elsewhere in the world.

K. Tomeoka and H. Kojima, in a print only contribution, describe two meteorites (Yamato 82162 and Yamato 86720) whose oxygen isotope data indicate that they are Cl but whose mineralogy and petrology indicate that they are metamorphosed CM chondrites.

To those participating, the sessions seemed well worthwhile. Considerable agreement was reached that there were differences, and that weathering and pairing must be carefully taken into account in discussions of those differences. It was also clear that weathering was an extremely complicated process whose effects would probably need to be evaluated independently for each technique applied, and that problems addressed through statistical distribution of data will first have to settle the pairing details for the samples involved.

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