THE SHERGOTTITES ARE YOUNG

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Introduction: Recently, Bouvier et al. (2006), interpreting their Pb isotopic data, have inferred that the shergottite suite of the SNC (martian) meteorites have ancient ages of ~4-4.5 b.y. But conventional wisdom has it that the shergottites are much younger (~500-150 m.y.) Are the shergottites young or are they ancient rocks whose ages have been reset by metamorphism or alteration?

Are the shergottites metamorphic rocks? No. They are igneous rocks whose constituent minerals retain their igneous zoning. Even olivine, which equilibrates quickly, may be zoned.

Have the shergottite ages been reset by shock? No. Jones (1986) gave arguments against shock equilibration in excruciating detail. A synopsis of this issue can be given by consideration of the shergottite EET79001: (i) EET79001 has a young Sm-Nd age but the olivines and pyroxenes in EET retain igneous zoning. If chemical equilibration of divalent ions was not achieved during shock (or metamorphism), it is nearly impossible to have achieved isotopic equilibration of trivalent ions (i.e., REE). Isotopic equilibration is achieved by diffusion, and trivalent ions diffuse more slowly in mafic silicates than divalent ions do. This is because local charge balance must be maintained. (ii) EET79001 contains two lithologies (A&B) with very different compositions. These lithologies define two distinct Rb-Sr isochrons. The first analyses of impact melt glasses produced from these two lithologies plotted on their respective isochrons. However, these very different glasses were extracted from a single lithology — lithology A. Therefore, the B impact melts did not have time to isotopically equilibrate with their A surroundings.

Have shergottite ages been reset by low-temperature alteration? No. Bouvier et al. postulate that the Rb-Sr and Sm-Nd systems have been disturbed because of low temperature alteration/exchange. However, there is no evidence for this. Using Shergotty & Zagami as examples: (i) Low-T alteration products are rare to non-existent (McCoy et al., 1992); (ii) If exchange occurred with a hydrous fluid, it did not affect oxygen — oxygen isotopic equilibration temperatures for several mineral pairs in Shergotty yield an equilibration temperature of 1100±100°C (Clayton & Mayeda, 1986). [cf., the solidus temperature for Zagami is 1000-1050°C (McCoy & Lofgren, 1999)]; (iii) Acid-leached residues from Zagami define a Sm-Nd isochron of 157 m.y. (Borg et al., 2005).

This latter observation goes directly to the heart of the issue. The whole-rocks and mineral separates are chemically (i.e., normally) and isotopically zoned. They were cleansed of possibly altered impurities such as phosphates both by meticulous hand-picking and subsequent acid leaching. For Bouvier et al. to be correct, this isochron should have yielded a very old age, and it did not.

Have young shergottite ages been confirmed by multiple chronometer systems? Yes. Recent work on Zagami yielded Rb-Sr, Sm-Nd, and ^{238}U-^{206}Pb ages of 166±16, 166±12, and 156±18 m.y., respectively (Borg et al., 2005). Although it is desirable to have multiple chronometers applied to the same aliquot of sample, the Borg et al. results are in good agreement with previous workers, who used other samples of Zagami.

These accumulated observations are inconsistent with an ancient age for the shergottites.