^{40}Ar/^{39}Ar AGES FOR MASKELYNITES AND K-RICH MELT FROM OLIVINE-RICH LITHOLOGY IN (KANAGAWA) ZAGAMI.

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Introduction: We report Ar/Ar release patterns for small maskelynite grains and samples of a K-rich phase separated from the basaltic shergottite Zagami. The purpose of the work is to investigate the well-known discrepancy between published Ar/Ar ages of Zagami, >200 Ma, and its age of ~ 170 Ma as determined by other methods [1-6].

Niihara et al. [7] divide less abundant darker material present in Zagami into an olivine-rich lithology (ORL), from which most of our samples came, and a pyroxene-rich one (Dark Mottled-Lithology: DML) [8, 9]. ORL consists of vermicular fayalitic olivine, coarse-grained pyroxene, maskelynite, and a glassy phase exceptionally rich in K (up to 8.5 wt%), Al, and Si, but poor in Fe and Mg. The elemental composition suggests a late-stage melt, i.e., residual material that solidified late in a fractional crystallization sequence. Below we refer to it as “K-rich melt.” The K-rich melt contains laths of captured olivine, Ca-rich pyroxene, plagioclase, and opaques. It seemed to offer an especially promising target for ^{40}Ar/^{39}Ar dating.

Experimental Methods: From the K-rich melt we hand-picked ~1400 μg and chose randomly 8 samples (100-300 μg) for Ar/Ar analysis. We also received a few grains of maskelynite separated by hand-picking the main mass (ORL) of 54-1 from which we chose for analysis 4 grains (12-25 μg). EDS or XRF analysis confirmed the identity of the maskelynites and gave K concentrations from 0.8 to 4 wt% in the K-rich melt. The samples were packed in evacuated (confirm) glass tubes, wrapped in Cd foil 0.5 mm thick to reduce the thermal neutron fluence, and irradiated for ~80 h at the USGS Triga reactor.

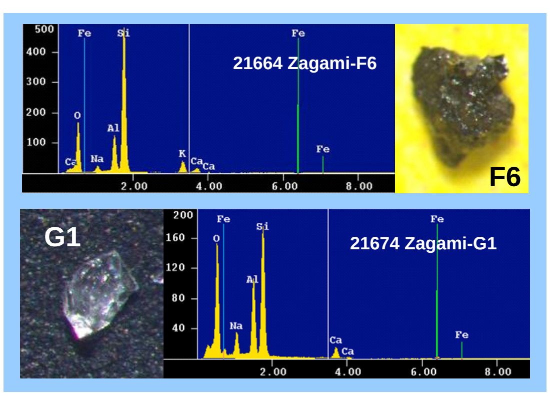

Fig. 1. EDS spectra for K-rich melt F6 (315 μg, 673×697 μm) and maskelynite G1 (25 μg, 430×348 μm).

Results & Discussion: *^{40}Ar/^{39}Ar plateau ages of Zagami plagioclase grains.* Ar release plots (Figure 2) are flat within the uncertainties for 30-100% of the ^{39}Ar release; the ages for sample 21677 (not shown) are larger and have larger uncertainties. Older ages for the first release steps probably reflect contamination by terrestrial atmospheric argon. The weighted mean high-temperature ages for the three grains shown are 240±28, 240±24, and 216±46 Ma. Despite some scatter, the K/Ca ratios are generally constant. For comparison, [1] shows for a Zagami maskelynite separate of ~10 mg a gently rising release pattern with a mean age of ~250 Ma. The release pattern of [10] for a 10-mg plagioclase separate slopes downward from perhaps ~275 Ma to 200 Ma. [11 referred to as [2] below?] reported release patterns for maskelynite separates, each ~10 mg, for coarse-grained (CG) and fine-grained (FG) samples of Zagami.

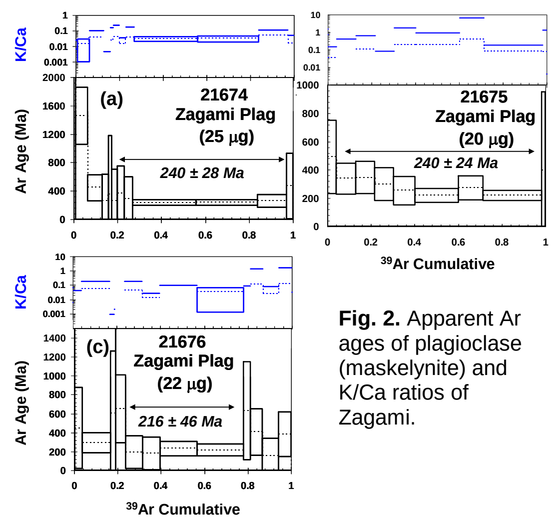

Fig. 2. Apparent Ar ages of plagioclase (maskelynite) and K/Ca ratios of Zagami.

Isochrons for plagioclase. With amounts of $^{36-38}$Ar in the range of 10^{-18} mol, many of our measurements were close to blank levels and, accordingly, the results we obtained for the maskelynite grains have large uncertainties. Grain G1, however, defines a convincing isochron: age=205±27 Ma; intercept=242±30. By pooling the plagioclase data we obtain a higher age 261±16 Ma but a similar intercept, 216±22. Published isochron ages and intercepts were (CG) 232±21 Ma; inte

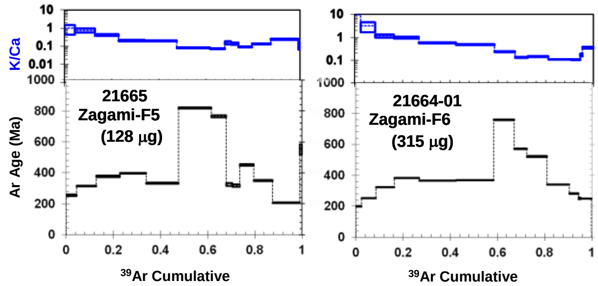

Fig. 3. Apparent Ar ages and K/Ca ratios of K-rich melts

rcept=351±98; (FG) 309±15 Ma; intercept = 216±41, respectively [2].

^{40}Ar/^{39}Ar plateau ages for K-rich melt. Whereas the release patterns of the plagioclase grains are flat with most ages <300 Ma, those of the K-rich melt samples have structure and typical ages >400 Ma (Figure 3): Generally, the patterns resemble those reported for glass from the shergottite NWA 3171 [11] and for ~0.9 mg of opaque material analyzed by [10] .

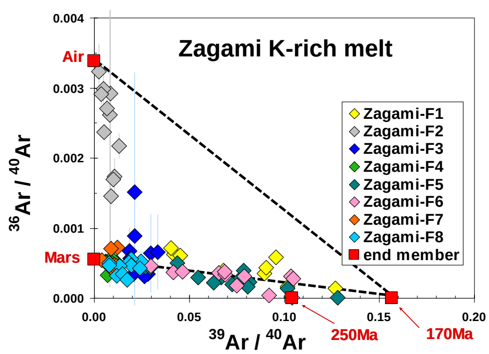

Fig. 4. Inverted isochron for fragments F1-F8 of K-rich melt.

Ar isotopic systematics of the K-rich melt. The EDS and Ar results for eight samples of K-rich melt (F1-F8), reflect the heterogenous chemical composition of this material. An inverse isochron plot (Fig. 4) distinguishes separate fragments of the K-rich melt. Nevertheless, data for all the fragments clearly plot within and generally along the boundaries of a triangle defined by end members of terrestrial air, a "Mars signature" corresponding to ^{40}Ar/^{36}Ar ~2000, and a radiogenic component corresponding to an age of ~170-250 Ma.

Isochrons for two-component "Mars" mixing end members. Fig. 5 shows a conventional isochron samples F5-F8, selected because the data follow the lower boundary of Fig. 4 and are therefore consistent with "two-component" mixing between a 'Mars' and a radiogenic component. This isochron for samples yields an age of 187±12 Ma and an intercept of 1883±27.

Conclusions: Ar data for Zagami maskelynites verify previous results and show that plagioclase is homogeneous with respect to the behavior of the K/Ar system down to a sampling scale of ~20 µg. The isochron age of the K-rich melt improves agreement among the Ar-Ar, Sm/Nd, and Rb-Sr ages of Zagami.

The high value of the ^{40}Ar/^{36}Ar intercept, ~2000, inferred from the isochrons for the K-rich melt requires explanation. Argon with a similar ^{40}Ar/^{36}Ar ratio was found as "Trapped-B" in RBT 04262 and LAR 06319 pyroxene separates [12]. It was explained as due to the presence of Ar with an isotopic composition similar to that in the Martian atmosphere in the RBT and LAR melts at the time of solidification [13, 14]. Whether it reflects the presence of radiogenic ^{40}Ar from the mantle that survived partial degassing in a magma at the time of solidification ~ 180 Ma ago, or whether it represents Martian atmospheric Ar incorporated into the shergottite melt via crustal rocks is presently unclear.

An origin via shock-implantation from the Martian atmosphere is inconsistent with the petrologic setting of the K-rich melt in ORL. Furthermore, in analyses of RBT, LAR, and Zagami this Ar component degasses at the highest temperatures from pyroxene, one of the first mineral phases in the crystallization sequence.

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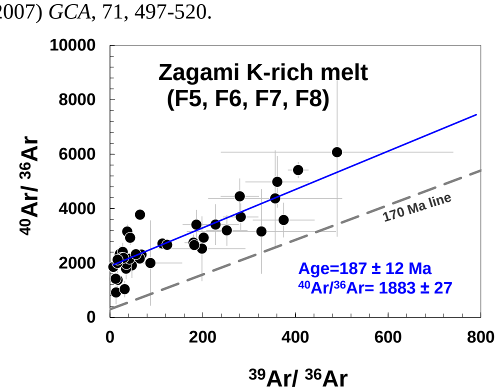

Fig. 5. Isochron plot for the most "radiogenic" frag ments of K-rich melt.