Hydrothermal activity on Mars revealed by basaltic shergottite Y 002192

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Mars was considered as an Earth like planet in the first 500 Ma, showing widespread of phyllosilicates on the ancient terrain (Bibring et al., 2005; Ehlmann et al., 2011). The hydrothermal activity on Mars has confirmed in Martian meteorites which show alteration minerals in Nakhla (Hallis et al., 2012) and have significantly higher δD values compared to Martian mantle (Boctor et al., 2003; Chen et al., 2015; Hu et al., 2014; Mane et al., 2016; Usui et al., 2012; Watson et al., 1994). However, basaltic shergottites were rarely studied because these samples usually don't have typical melt inclusions enclosed by olivine and chromite. Here we report the new results of the water contents and hydrogen isotopes of a basaltic shergottite Y 002192.

Y 002192 is a newly classified basaltic shergottite, recovered from Yamato Mountain area, Antarctica. The petrography details were obtained with FE-SEM at NIPR and the water contents and hydrogen isotopes were measured at IGGCAS using NanoSIMS. Y 002192 is mainly comprised of pyroxene and maskelynite with minor phosphates, ilmenite, sulfide, and magnetite. A thin shock melt vein (SMV) is visible in the polished thick section. Tuite and stishovite were found in this SMV and several melt inclusions were found in ilmenite. Water contents and hydrogen isotopes of melt inclusions, SMV, maskelynite, and feldspathic glass enclosed by pyroxene were analyzed in this work, following the method of Hu et al. (2014) and Hu et al. (2015).

The water contents and hydrogen isotopes of Y 002192 varied from 17-8974 ppm and 182-5981 ‰ respectively. They are logarithmically correlated along two-endmember mixing trend as other Martian shergottites except for several spots show high water contents but low δD values. The water contents and hydrogen isotopes of feldspathic glasses enclosed by pyroxene are similar with melt inclusions enclosed by ilmenite, both of them have high water contents and low δD value spots, probably record a terrestrial contamination event or host the pristine Martian interior water. Nevertheless, the feldspathic glasses enclosed by pyroxene and melt inclusions enclosed by ilmenite record a significant interaction with Martian meteoritic water reservoir. Major maskelynite has little water contents and low δD values except for the interface areas contact with pyroxene. The maskelynite profile analysis shows that the water contents and hydrogen isotopes of maskelynite are zoned with higher values at the rims and decrease towards the cores. In contrast, the water contents and δD values of SMV are intermediate between melt inclusions and maskelynite, suggesting it formed after the melt inclusions interacting with Martian meteoritic water. At present, feldspathic glasses enclosed by pyroxene and maskelynite in Y 002192 show similar texture and chemical composition, however, significant differences in water contents and hydrogen isotopes between them suggest they experienced different post-crystallization hydrothermal activities. After the eruption of the parent magma of Y 002192, melt inclusions enclosed by ilmenite and feldspathic glasses enclosed by pyroxene were quenched to glasses, then these glassy phases experienced a hydrothermal activity to improve the δD values. Some time later, the parent rock of Y 002192 experienced an asteroid shock impact to transform plagioclase into maskelynite. The diffusional profile in maskelynite might be formed from the asteroid impact or indicating an extra short hydrothermal activity. Meanwhile, the SMV was formed during the asteroid impacting the parent rock, mixing high water contents and high δD glassy phases with anhydrous minerals.

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