**A TALE OF TWO SHERGOTTITES: RBT 04261 AND RBT 04262.** K. Nishiizumi[1] and M. W. Caffee[2], [1]Space Sciences Laboratory, University of California, Berkeley, CA 94720-7450, USA (kuni@ssl.berkeley.edu), [2]Department of Physics, Purdue University, West Lafayette, IN 47907-1396, USA (mcaffee@purdue.edu)

**Introduction:** Two Martian meteorites RBT 04261 and RBT 04262 were found in Roberts Massif (RBT), Antarctica. RBT 04261 is 4.0 x 3.5 x 2.5 cm in size and has a mass of 78.8 g. Likewise, RBT 04262 is 6.5 x 5.5 x 3.5 cm and 204.6 g. The exteriors of both meteorites are partially covered by fusion crust. Both meteorites were initially classified as olivine-phyric shergottites [1]. They have similar textures and mineral compositions, and were recovered from the same icefield [1, 2]. Accordingly, they were presumed to be paired. Closer investigation of RBT 04262 raised the possibility that it should be reclassified as a lherzolitic shergottite, even though its petrology and mineralogy differs slightly from previously known lherzolitic shergottites [3]. A possible difference in provenance raises the possibility that these two shergottites are not paired. Cosmogenic stable- and radionuclides can be used to determine the exposure histories, terrestrial ages, and ejection conditions from the Mars. From these we can ascertain whether these shergottites were ejected from Mars by the same event. In addition to their complement of galactic cosmic ray (GCR) produced nuclides some Martian meteorites contain nuclides produced by solar cosmic rays (SCR), which may further elucidate the shielding conditions of these meteorites *en route* to Earth. We report here results of the three cosmogenic radionuclides: $^{10}$Be ($T_{1/2}$ = 1.36 Myr); $^{26}$Al (0.705 Myr); and $^{36}$Cl (0.30 Myr) in RBT 04261 and RBT 04262. Measurements of $^{41}$Ca (0.104 Myr) and $^{53}$Mn (3.7 Myr) are in progress.

**Experimental and Results:** For both samples, exterior locations were samples. For RBT 04262 an interior chip, well away from the surface was also prepared. The exterior samples from each were subdivided into smaller samples on the basis of their distance radially away from the fusion crust. In each case something of a depth profile was prepared. Each sample was dissolved in an HF/$HNO_3$ mixture in the presence of the Be and the Cl carrier solutions. After taking aliquots for chemical analyses, Be, Al, Cl, Ca, and Mn were chemically separated and purified for AMS measurements. Concentrations of Al, Ca, Mn, and Fe in each sample were measured by atomic absorption spectroscopy (AAS). The results of these measurements are shown in Table 1. The AMS measurements of $^{10}$Be, $^{26}$Al, and $^{36}$Cl were performed at the PRIME Lab, Purdue University. The normalized concentrations of the cosmogenic radionuclides are also shown in Table 1 [4-6].

*RBT 04261.* The 0.59 g chip, RBT 04261,7 was divided into two sub-samples. The first sampled the depth ranging from 0-1.5 mm from the surface with the fusion crust and while the second was extracted from 5-8 mm away from the fusion crust. The major element abundances and cosmogenic nuclide concentrations of both samples are nearly identical, with the exception $^{26}$Al. The higher $^{26}$Al concentration in the surface sample indicates SCR production of this nuclide in space. Furthermore, this fragment must have been within several cm of the surface in space. Its preservation demonstrates low ablation, < 1 cm, during atmospheric entry. Assuming uniform, the pre-atmospheric size of this object is only ~6 cm. This is smaller than ALH 77005, another shergottite containing a high concentration of SCR produced nuclides. The $^{10}$Be exposure age is 3.0±0.6 Myr, assuming a $^{10}$Be production rate of 17-20 atom/kg·min. The $^{36}$Cl terrestrial age is less than 60 kyr. Measurements of cosmogenic nuclides on the opposite side and interior would be required to rigorously constrain the pre-atmospheric size and more accurately determination of the exposure age.

*RBT 04262.* A 0.57 g of the exterior chip, RBT 04262,7 was divided into three sub-samples on the basis of the depth in from the fusion crust: 0-1 mm; 1-3 mm; and 3-5 mm. RBT 04262,10 was the interior sample. The chemical compositions and cosmogenic radionuclide concentrations in all four sub-samples are indistinguishable from each other. The flat $^{26}$Al profile shows no SCR effects are present, indicating that the ablation depth was more than a few cm. The $^{36}$Cl concentration of the meteorite, averaging 4.3±0.1 dpm/kg (Fe+8Ca+16K), is the lowest among all Martian meteorites and is only explained by decay of the radionuclide during a long terrestrial residence time. The $^{36}$Cl terrestrial age is 710±60 kyr, which is more than twice that of Dhofar 019 (310 kyr) or QUE 94201 (250 kyr). The $^{10}$Be and $^{26}$Al concentrations at the time of fall are 12.2±0.4 dpm/kg and 59±1 dpm, respectively. The $^{10}$Be exposure age is 2.0±0.5 Myr assuming a $^{10}$Be production rate of 18-22 atom/kg·min. The average of the $^{3}$He, $^{21}$Ne, and $^{38}$Ar noble gas exposure ages of RBT 04262 is 2.3±0.6 Myr [7], which agrees with the $^{10}$Be age.

**Discussion:** RBT 04261 and RBT 04262 are the only Martian meteorites among the 229 meteorites found at Roberts Massif-Beardmore Region. These two meteorites were only 790 m apart from each other.

Location alone would suggest pairing. Similar petrology, mineralogy, and chemical composition buttress the assumption of pairing. The cosmogenic radionuclides unequivocally indicate that these two shergottites are not paired. However, the cosmogenic radionuclide data indicate that RBT 04261 and RBT 04262 were completely different objects in space and different falls. Somewhat surprisingly though, the ejection age, the sum of exposure and terrestrial ages, of RBT 04262 is 2.9±0.6 Myr, indistinguishable from that of RBT 04261. This ejection age is well within one of the major age clusters of shergottites ejection ages. Other cosmogenic radionuclides, such as $^{14}C$, $^{41}Ca$, and $^{53}Mn$, as well as noble gas measurement in RBT 04261 are required for further investigation.

**Conclusions:** Our cosmogenic radionuclide ages indicate that the shergottites RBT 04261 and RBT 04262 are different falls and that the objects were separate entities in space. Nonetheless, our chemical analyses indicate both objects have the same chemical composition, based on major elements. The $^{36}Cl$ terrestrial age of RBT 04262 is 0.7 Myr. To date it is the oldest Martian meteorite. Our data do indicate a coherent, albeit extremely unlikely, explanation for these objects. Both objects were ejected 2.9 Myr ago as separate fragments. RBT 04262 impacted Earth 0.7 Myr ago, while RBT 04261 landed < 60 kyr ago. This scenario is consistent with the cosmogenic nuclide data, however, the fact that both objects were found within 1 km of each other is an inexplicable coincidence.

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**References:**

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Table 1. Chemical composition and cosmogenic nuclides concentration of RBT 04261 and RBT 04262.

| Sample | Depth (mm) | Al (%) | Ca (%) | Mn (ppm) | Fe (%) | $^{10}Be$ (dpm/kg) | $^{26}Al$ (dpm/kg) | $^{36}Cl$ (dpm/kg) | $^{36}Cl$ (dpm/kg*) |
|---|---|---|---|---|---|---|---|---|---|
| RBT 04261,7 | 0-1.5 | 2.39 | 3.29 | 3740 | 17.6 | 14.52±0.18 | 83.2±1.9 | 8.70±0.39 | 19.43±0.87 |
| RBT 04261,7 | 5-8 | 2.64 | 3.46 | 3780 | 18.0 | 13.81±0.35 | 68.7±2.9 | 8.97±0.30 | 19.23±0.64 |
| RBT 04262,7 | 0-1 | 2.25 | 3.71 | 3720 | 16.6 | 9.27±0.26 | 30.4±1.1 | 2.01±0.08 | 4.27±0.17 |
| RBT 04262,7 | 1-3 | 3.23 | 3.60 | 3630 | 17.7 | 8.56±0.20 | 30.4±1.0 | 2.07±0.08 | 4.38±0.16 |
| RBT 04262,7 | 3-5 | 2.19 | 3.81 | 3760 | 17.3 | 8.30±0.28 | 28.4±0.9 | 2.08±0.06 | 4.26±0.12 |
| RBT 04262,10 | interior | 2.13 | 3.62 | 3510 | 18.0 | 7.95±0.18 | 28.0±0.9 | 2.02±0.07 | 4.22±0.14 |

*dpm/kg (Fe+8Ca+16K)