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UNMELTED ACHONDRITIC MICROMETEORITES FROM THE NOVAYA ZEMLYA GLACIER

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Introduction: During the last decades, a huge number of micrometeorites (MMs) were collected from glaciers of Greenland and Antarctica [1]. It has been well established that MMs are related to carbonaceous chondrites mostly [2] and only one basaltic unmelted MM (UMM) and rare achondritic cosmic spherules were found in Antarctic MM collections [3, 4]. A large suite of MMs was recovered from glacier deposits located at the Novaya Zemlya ice sheet. The particles comprise melted, partially melted and unmelted groups of micrometeorites. UMMs are dominated mostly by chondritic matter but also achondritic UMMs are present.

Description: Out of a total sample of 176 UMMs four—according to their textures, mineralogy, and chemistry—are classified as basaltic breccias. They have irregular shape and are transected by irregular cracks; with two of them containing vesicles. Two particles have discontinuous magnetite rims. Three particles consist of angular mineral fragments embedded in various glassy matrices. The constituent phases are low- and high-Ca pyroxenes, plagioclase, silica, ilmenite, chromite, and glass. Compositions of pyroxenes in the UMMs differ from each other with average Fs contents of low-Ca pyroxenes of 10, 30, 55, and 58 mol% in particles NZ6-2-4,5, NZ6-2-4,33, NZ6-1-1,44, and NZ6-2-5,15 respectively. The composition of high-Ca pyroxenes is $Fs_{5–6}Wo_{38–44}$, $Fs_{35–42}Wo_{18–24}$, and $Fs_{42–48}Wo_{19–24}$ for UMMs NZ6-2-4,5, NZ6-1-1,44, and NZ6-2-5,15 respectively. The pyroxene average Fe/Mn atomic ratios for UMMs NZ6-2-4,33 and NZ6-2-5,15 are 31 and 30, respectively, whereas UMMs NZ6-1-1,44 and NZ6-2-4,5 have Fe/Mn ratios of 24.6 and 18.7, respectively. Plagioclase in three UMM is bytownite and UMM NZ6-2-4,5 contains $An_{75–65}$. Bulk compositions of the particles obtained by defocused microprobe beam technique are close to basalts.

Summary: Based on textures and compositions of basaltic melt breccia UMMs we suggest that they originated from surface layers of a basalt-bearing asteroid that has been re-worked by high velocity impacts. Pyroxene Fe/Mn ratios combined with An contents in plagioclase [5] indicate for two UMMs a possible relationship to eucrite and/or mesosiderite meteorites whereas two others seem to have two distinct parent bodies of a composition, which is not present in meteorite collections. However, the conclusion needs to be further investigated utilizing trace element abundances and isotope studies. The basaltic breccia UMMs constitute 0.5% of the total population of the Novaya Zemlya MM suite. This content should be lowered to 0.25% if this MM collection is biased statistically due to depletion in some group(s) of UMMs, e.g., carbonaceous UMMs.

Acknowledgments: This work was funded by CNRS-RFFI PICS (grant *No* 07-05-92165), RFFI (grant 09-05-00444-α), FWF in Austria and the Academy of Sciences of Austria and Finland.

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^{81}KR-KR AGE OF THE VACA MUERTA MESOSIDERITE: ON THEIR PARENT BODY EXPOSURE

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Introduction: Vaca Muerta is classified as a mesosiderite, a breccia of approximately equal mixture of silicate and metal [1]. The mesosiderite includes several types of igneous pebbles [2], of which various textures suggest collision event(s) between differentiated asteroidal bodies for its formation. The unique textures have been attracting interests to investigate formation mechanisms and histories of Vaca Muerta mesosiderite. Since the formation process of mesosiderite is complicated, multi-stage cosmic-ray irradiation is also conceivable. A portion which had existed on surface layer (< 3 m) of the parent body would show evidence for cosmic-ray exposure. We utilized ^{81}Kr-Kr method to investigate different histories of cosmic-ray exposure (CRE) among the different rock types from the Vaca Muerta.

Sample and Experimental: We measured two chips of different lithologies taken from a Vaca Muerta sample; a general metal-rich brecciated rock (VM-B) and a coarse grained gabbroic pebble (VM-P) which resembles polygenic and monogenic cumulates [2]. Abundances and isotopic ratios of noble gases were measured by using stepwise heating method with the modified VG5400 (MS-II) mass spectrometer at the University of Tokyo. Duplicate measurements of ^{81}Kr-Kr ages were carried out on each sample to confirm the obtained ages.

Results and Discussion: The production rate ratio ^{81}Kr/^{83}Kr for the samples were determined using a least squares fitting to the Kr isotopic data obtained by the stepwise heating method. Resulted ^{81}Kr-Kr ages for the VM-B and VM-P samples are 141 ± 9 and 167 ± 9 Myr, respectively. ^{36}Cl-^{36}Ar CRE age of 138 ± 11 Myr [3] was reported for metal phase (VM-M) from the Vaca Muerta. The CRE age of VM-P is longer than those for VM-B and VM-M, indicating that the VM-P had been irradiated in addition to the space irradiation, ~140 Myr, during transit from the parent body to the Earth as observed for VM-B and VM-M.

The difference of CRE ages among the samples reveals that VM-P was irradiated by cosmic rays on its parent body, on which only VM-P was present on the surface. This result is consistent with the model calculation for its temperature evolution by Stewart et al. [4]. They mentioned burial depths greater than ~20 m for metal or ~1 m for regolith which corresponds to the VM-P sample. A precursor of VM-P had been located in shallower depth than VM-M and VM-B. It is considered reasonable that a mixing of VM-B and VM-P occurred before the impact metamorphism and reassembly due to collisional breakup [5] of the Vaca Muerta parent body at ~3.8 Gyr ago [6], because recent large-scale mixing on the parent body is unlikely due to a lack of chance and driving force of the agitation.

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