ALLAN HILLS 12073: A METAL-RICH EUCRITE.

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Recovery: Allan Hills 12073 is a 500 mg meteorite fragment, partially covered by fresh fusion crust, recovered from the Near Western Allan Hills ice field, during the 2012-2013 campaign of the Italian Programma Nazionale di Ricerche in Antartide (PNRA).

Sampling and Methods: ALH 12073 was split into three fragments. One fragment (~150 mg) was used to prepare a thin section for petrographic description and EMP analysis. A second fragment of about 150 mg, devoid of fusion crust, was split in two smaller chips. The larger one, of about 105 mg, was prepared for solution ICP-MS analysis. The smaller one was ground and homogenized for triple oxygen isotope measurements. The third fragment was embedded in resin, sectioned and polished for bulk Hand-Held XRF analysis. Three pyroxene crystals, of about 300 microns in size each, were selected for X-ray single-crystal diffraction and structure refinement. Two plagioclases of about 4 mg in mass were extracted for ^{39}Ar-^{40}Ar dating (the plagioclases are under irradiation at the writing of this abstract, May 2016).

Petrography: In thin section, ALH 12073 shows unbrecciated, inequigranular, medium- to fine-grained subophitic texture. It maily consists of subhedral plagioclase (46 vol%) and low-Ca pyroxene (34 vol%), plus minor euhedral tridymite (7 vol%), high-Ca pyroxene (4 vol%), Fe,Ni metal (4 vol%), sulfide (3 vol%), phosphates (2 vol%) and traces of chromite.

Mineral Chemistry: The low-Ca pyroxene is orthopyroxene ($En_{63.1}$, $Fs_{33.9}$, $Wo_{3.1}$) with a relatively uniform composition, and average Fe/Mn ratio of 26. It hosts few, local, fine-exolved Ca-rich lamellae. The plagioclase is anorthite ($An_{92.4}$, $Ab_{7.5}$, $Or_{0.2}$). The high-Ca pyroxene is augite (En 43.3, Fs 16.1, Wo 40.5). It is exolved and displays two systems of Ca-poor lamellae. The chromite is Mg-rich with an average Mg# of 10%. The Fe,Ni metals are divided in low Ni-phase (kamacite) and high Ni-phase (taenite).

Thermospeedometric constraints: Opx-Cpx pairs provide an average equilibrium crystallization temperatures of T = 961 ± 21 °C; the closure temperature of the Fe-Mg cation ordering in three orthopyroxenes (Fs_{36}) determined through the calibration curve by [1], Tc, are 891 ± 23, 968 ± 22 and 979 ± 27 °C.

Oxygen isotope composition: Triple oxygen isotope composition of ALH 12073 ($\delta^{18}O$ = 4.4 ± 0.15‰; $\delta^{17}O$ = 2.09 ± 0.15‰) is, within uncertainty, in the range of HED meteorites.

Bulk composition: Major element bulk data indicate that ALH 12073 is a sub-alkaline basalt (SiO_2 = 49.44 wt%; Na_2O+K_2O = 0.16 wt%). Compared with literature data for eucrites [2] ALH 12073 has on average higher Al_2O_3 (15% relative) and FeO (50% relative) content. These differences are indicative of higher modal proportion of plagioclase and metals.

The REE pattern is flat with relatively unfractionated La/Yb ratio (La/Yb_N=0.8) and a large positive Eu anomaly (Eu/Eu*=3.8) indicative of plagioclase accumulation. The concentration of incompatible lithophile trace elements such as Ba, Sr, Zr, Nb, Hf, Th, U and Rb exhibits striking similarities with cumulate eucrites. In turn, when compared to whole rock literature data, the siderophile elements (Ni, Co) plot far off the field of HED meteorites, towards higher concentrations.

Discussion: On the basis of pyroxene Fe/Mn ratio and oxygen isotope composition, the ALH 12073 basalt belongs to the HED family, i.e. it is an eucrite. The relatively high $\delta^{18}O$ value could reflect the high modal plagioclase content of the rock [3]. Pyroxene thermospeedometric data indicate quenching after equilibrium crystallization at temperatures of about 1000 °C. This is consistent with the occurrence of tridymite. The high metal and bulk siderophile element content are anomalous for eucrites and needs explanations. Several possibilities can be proposed: 1) introduction of foreign metal by impact [4]. 2) Change of $f(O_2)$ during crystallization. 3) Increase of sulfur partial pressure during heating and subsequent reduction [5]. 4) Kinship with metal-rich meteorites. All of these options will be discussed at the meeting.

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