SAYH AL UHAYMIR 085, CV3 CHONDRITE: MINERALOGICAL LINKS WITH CK CHONDRITES

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Sayh al Uhaymir 085 is similar to CV3 carbonaceous chondrites of the oxidized subgroup, and it has some peculiarities and characteristics of CK chondrites. We report on the petrography, mineral chemistry, and oxygen isotopic compositions of Sayh al Uhaymir 085, and discuss its peculiarities and origin.

Petrography and mineral chemistry. Sayh al Uhaymir (SaU) 085, a 112 g carbonaceous chondrite, was found in the desert of Oman on January 11, 2002. It is a black stone with a distinct fusion crust. In general, textures of SaU 085 are similar to those of CV3-chondrites, but the meteorite demonstrates some interesting unusual features.

In SaU 085, the matrix /(chondrule+aggregates) ratio is 0.77, similar to Allende and Mokoia, both oxidized CV chondrites, but also similar to the reduced CV chondrites [1]. This ratio differs from some other members of the oxidized subgroup (1.2, in Kaba, Bali, and Groznaya).

Only two chondrules, 0.2 and 1.4 mm in size, were found, which is very unusual for CV chondrites. They are of the porphyritic olivine- and pyroxene-rich (POP) textural type, both of type II. They contain magnetite and minor kamacite. Olivine and pyroxene are the dominant mineral phases in olivine aggregates; sulfide, spinel, chromite, and magnetite are accessory phases. The chondrule and aggregate mesostasis is completely altered, and no primary glass or plagioclase were found.

An unusual characteristic of SaU 085 is the presence of magnetite masses in the olivine aggregates. These magnetite objects, 20-100 μm in size, consist of Cr-rich magnetite with small kamacite inclusions, rare sulfides embedded in a matrix of fayalitic olivine, with traces of cronstedtite, and altered material.

Two fine-grained CAIs, 1 x 1 and 1.8 x 1.9 mm in size, were found in an SaU 085 section. They have a concentrically zoned structure and consist of spinel, melilite, anorthite, Al-diopside, forsterite, minor kamacite, and magnetite. The CAIs have undergone weak alteration, and rare nepheline and sodalite occur.

The matrix of SaU 085 contains fragments of FeO-rich olivine, pyroxene, magnetite, spinel, chromite, sulfides, and rare Fe metal. It also contains phyllosilicates, and in general, the intensity of the matrix alteration is similar to that in the Mocoia and Bali matrices.

Olivine compositions from chondrules and aggregates are in the range of those in CV chondrites, Fa 0.7-45%. In the rims of the CAIs, as well as in most aggregates, the olivine is forsteritic and shows limited zoning in FeO. Olivine contents of CaO, Al_2O_3, MnO, and Cr_2O_3 show similar trends to those in other CV chondrites [2]. Unlike the chondrules, olivine from the matrix has a wider range of composition (Fa 0.9-80%) and is more strongly zoned.

Pyroxene is represented by orthopyroxene (Wo3 En94), pigeonite (Wo10 En85), augite (Wo38En59), and diopside (WoEn45) in all constituents of SaU 085. Augite and diopside from the matrix, chondrules, and aggregates are enriched in Al_2O_3, 3.5 wt% and 7.8 wt% respectively. In the CAIs, Al-diopside occurs and is enriched in Al and Ti (Al_2O_3-32 wt%; TiO_2-15 wt%).

Spinel is FeO-rich with Fe/(Fe+Mg) = 0.3-0.6. In the CAIs, spinels have variable compositions from almost pure Mg-spinel to more ferroan contents, with (Fe/(Fe+Mg) up to 0.15). Rare chromite, Cr/(Cr+Al) = 0.7, was found only in the matrix.

Rare sulfide minerals are mostly pyrrhotite and troilite (Ni – 0.1-1.8 wt%). One pyrite grain was found in the matrix of SaU 085. Metal is rare and present as kamacite and taenite. Ni-rich taenite (up to 45 wt% Ni, 1.5 wt% Co) occurs only in the matrix, and kamacite was found in forsterite grains of aggregates, chondrules, CAIs, matrix, and in the magnetite objects.

Discussion. Based on petrography and mineral chemistry, SaU 085 is a new carbonaceous chondrite of the CV3 group with affinity to the oxidized group of CV chondrites. The relative abundance of magnetite is higher than that of FeNi metal in SaU 085, evidence of the oxidized nature of SaU 085.

Oxygen isotopic compositions of SaU 085 are in the CV-CO-CK field, at the ^{16}O poor end, with $\delta^{18}O$ is 3.4 ‰ and $\delta^{17}O$ is –1.7 ‰ (Fig. 1). However, it is in the range of oxidized CV chondrites.

Although SaU 085 belongs to the CV chondrites, several specific features are anomalous for typical members of theis oxidized subgroup of carbonaceous chondrites. These are: 1) a scarcity of chondrules; 2) the presence of complex magnetite aggregates; and 3) the absence of high-Ni sulfides, such as pentlandite. .

Some FeO-rich augites and diopsides from the SaU 085 matrix have high NiO contents similar to CK chondrites (0.7-3.3 wt% NiO) (Fig. 2), additional evidence for this oxidized type of CV chondrite. They also have less Al_2O_3 (1.3 wt%) than MgO-rich augite and diopside.

Magnetites have a varying composition in Cr and Mg that distinguishes SaU 085 from other CV chondrites

(Fig. 3). Cr contents of magnetite are mainly higher and Mg contents are lower than those of magnetites from other CV chondrites; however, these values are similar to those from CK chondrites [3]. Unlike Cr and Mg, the contents of Ni are low and mostly in the range of Ni contents of magnetite from the CV group, with some higher Ni.

Another anomalous feature of SaU 085, as an oxidized CV chondrite, is the absent of high-Ni sulfides. In comparison with another oxidized CV chondrites, SaU 085 doesn't contain any pentlandite. The presence of kamacite (Fe^0) inside magnetite (fe^{3+}) must show equilibration to low temperatures, such that the oxidation might have occurred below 560 °C.

Phyllosilicate compositions are in the range of serpentine solid solutions, close to phyllosilicate compositions of matrices of other CV chondrites, but also towards cronstedtite (Fig. 4). Based on the degree of alteration in the chondrules and aggregates and the occurrence of phyllosilicates in the matrix, we would appear that SaU 085 has experienced only moderate aqueous alteration.

Conclusions. The newly found meteorite SaU 085 appears to be a breccia consisting of major contributions of material from oxidized subgroups, some CK material, and minor material from the reduced subgroup of CV chondrites. This meteorite demonstrates interesting mineralogical features that are typical for CK chondrites – Cr-rich magnetite, NiO-rich diopside, and the presence of pyrite among the sulfide assemblage. Thus, SaU 085 confirms a genetic relationship between the oxidized group of CV chondrites and CK chondrites [4].

References [1] Brearley A.J. and Jones R.H. (1998) *In Planetary Materials, Ed. Papike J.J.* 398; [2] Rubin A.E., Wasson J.T. (1987) *Geochim. Cosmochim. Act.* 51, 1923-1937; [3] Geiger T and Bischoff A. (1995) *Planet. Space Sci.*, 43, 485-498; [4] Kallemeyn G. W. et al. (1991) Geochim. *Cosmochim. Act.* 55, 881-892.

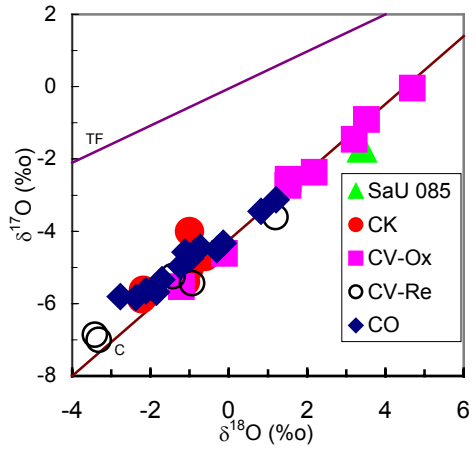

Fig. 1. Oxygen isotopic compositions.

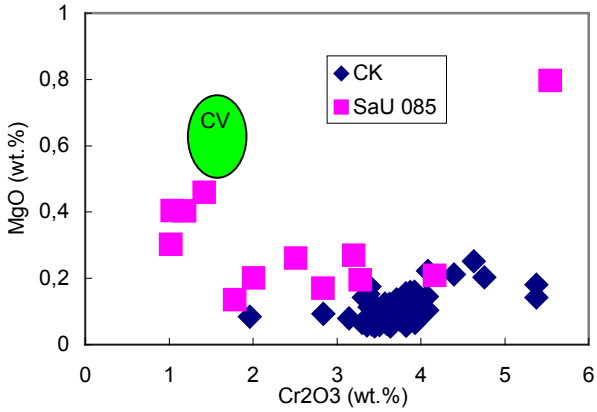

Fig. 3. MgO vs. Cr_2O_3 in magnetite.

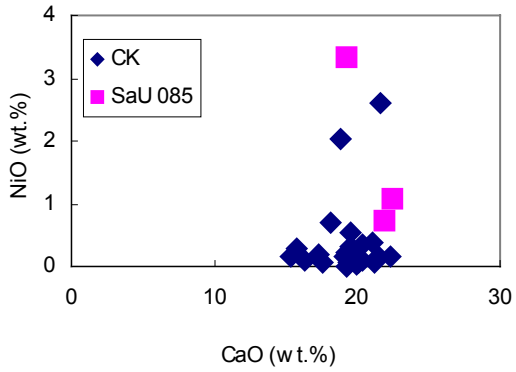

Fig. 2. NiO vs CaO in augite and diopside.

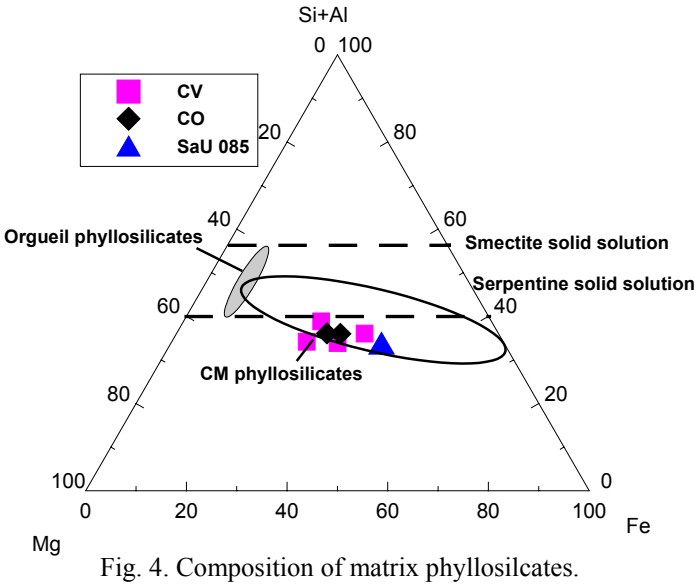

Fig. 4. Composition of matrix phyllosilcates.