CHEMICAL COMPOSITION AND FORMATION PROCESS OF SILICA-RICH CHONDRULE RIMS IN THE SAHARA 00182 CR/CV CHONDRITE. Y. Kakazu[1], T. Nakamura[1], I. Ohnishi[2], R. Okazaki[1] . [1]Department of Earth and Planetary Sciences, Faculty of Sciences, Kyushu University, Hakozaki, Fukuoka 812-8581, Japan. [2]Department of Earth and Planetary Sciences, Faculty of Science, Kobe University, Nada, Kobe 657-8501, Japan.

Introduction: Silica rich rims are one of important features that characterize CR chondrite [1, 2]. Silica-rich rims were found in some chondrules in the Sahara 00182 CR/CV chondrites [2]. We also found silica-rich rims that constitute the outermost layers around type I chondrules in the same meteorite. The rims contain a high abundance of silica phases. It is known that in the equilibrium condensation process, silica couldn't appear in the solar nebula. In order to obtain a better understanding on the formation of silica-rich rims, textural observation and major element analysis were performed by electron microscopes and a secondary ion mass spectrometer (SIMS imf 6f). Oxygen isotope analysis was carried out on olivine and pyroxene in the chondrules enclosed by silica-rich rims.

Results: Two chondrules having silica-rich rims were found and referred to hereafter as chondrule 1 and 2.

Chondrule 1; Chondrule 1 has layered structure. X-ray elemental mapping in Si shows that the edge of chondrule 1 is highly enriched in a silica phase and the core is type I POP (Fig. 1). The core consists mainly of olivine, low-Ca pyroxene, Fe,Ni-metal, troilite, and glassy mesostasis. The abundance ratio of olivine and pyroxene in the core is about 8:2. Troilites show angular and irregular shape with 50~400μm.

The outermost silica-rich rim with thickness from 20 to 200μm is mineralogically and texturally distinct from the core. The silica-rich rim consists of silica, low- and high-Ca pyroxene, Fe,Ni-metal, and no olivine (Fig. 2). The silica shows lath-shaped texture and is embedded in mesostasis or intergrown with pyroxenes. The size of silica ranges from 20 to 50μm and the size of pyroxene ranges from 20 to 100μm. The abundance of Fe, Ni-metal in the silica-rich rim is generally lower than that in the core. The size of the metal in the silica-rich rim is smaller than that in the core. The abundance of troilite in the silica-rich rim is low.

United X-ray elemental mapping in Si, Mg and Al shows a stacking sequence of separate layers: the chondrule 1 consists of olivine core, surrounded by low-Ca pyroxene, and further surrounded by the silica-rich rim. The silica-rich rim is not in direct contact with the olivine core, but is separated from it by the layer of the pyroxene. It suggests that olivine reacts with silica and formed the pyroxene.

Olivine in the core has a mean composition and one sigma variation of Fa 7.8±0.4 mol% (n=16) with minor amounts of MnO (0.23±0.05 wt%). CaO (<0.1 wt%) and Cr_2O_3 (<0.1 wt%) contents are low. Low-Ca pyroxene in the core has a mean composition and one sigma variation of Fs 6.9±1.1 Wo 0.8±0.2 mol% (n=18) and has Cr_2O_3 (0.42±0.29 wt%), MnO (0.16 ±0.07 wt%), and TiO_2 (0.09±0.06 wt%).

On the other hand, low-Ca pyroxene in the silica-rich rim has slightly richer in FeO than that in the core: Fs 8.0±1.2 Wo 1.0±0.5 mol% (n=21) and has Cr_2O_3 (0.47±0.38 wt%), MnO (0.28±0.10 wt%), and TiO_2 (0.09±0.05 wt%). High-Ca pyroxene in the silica-rich rim has Fs 3.8±4.5 Wo 40.4±5.6 mol% (n=19) and has Cr_2O_3 (1.57±0.68 wt%), MnO (1.17±0.53 wt%), and TiO_2 (0.52±0.2 wt%). The average composition of the silica is: SiO_2 (97.17±1.01 wt%) (n=3), Al_2O_3 (0.13±0.02 wt%), FeO (0.16±0.04 wt%).

We obtained bulk composition of the chondrule core and the silica-rich rim separately, using broad electron beam of 40μm in diameter. The compositions, normalized to Mg and CI carbonaceous chondrite, are shown in Fig 3. The core depleted relative to CI in all the elements plotted. The silica-rich rim is enriched in Ca, Al, Ti, Si, Cr, Mn, Na and K and depleted in Fe, Ni and S relative to CI.

Oxygen isotope ratio for olivine in the core is varying from -4 to -2 ‰ in $\delta^{18}O$ and from -7 to -5‰ in $\delta^{17}O$. Pyroxene in the core exhibits from -2 to 1 ‰ in $\delta^{18}O$ and from -5 to -3 ‰ in $\delta^{17}O$. All the data sets from the core make a cluster around the CCAM line.

Chondrule 2; Chondrule 2 is type I POP chondrule and the core consists of the same mineral as chondrule 1. Chondrule 2 diameter (2.5mm) is larger than chondrule 1 (1.75mm). Unlike chondrule 1, olivine and pyroxene occur in the core in approximately equal proportions.

Like chondrule 1, chondrule 2 has the silica rich rim and the thickness (50~300μm) is a little thicker than that in chondrule 1. The silica-rich rim is mineralogically and texturally similar to chondrule 1.

Olivine and low-Ca pyroxene in the core have a mean composition and one sigma variation of Fa 7.8± 0.4 mol% (n=20), Fs 4.7±2.5 Wo 0.6±0.1 mol% (n=20) and their minor element compositions similar to chondrule 1. Low-Ca pyroxene in the core is slightly depleted in FeO compared to chondrule 1.

In contrast, low-Ca pyroxene in the silica-rich rim has slightly richer in FeO than that in the core Fs 8.1±0.9 Wo 1.0±0.7 mol% (n=28). High-Ca pyroxene

in the silica-rich rim has Fs 2.0±1.0 Wo 37.5±4.9 mol% (n=16). Both low- and high-Ca pyroxene in the silica-rich rim have minor element contents similar to those in chondrule 1. The average composition of the silica is also similar to chondrule 1.

We obtained bulk composition for the chondrule core and the silica-rich rim separately, using broad electron beam with 40μm. Element patterns of both the core and the silica-rich rim are similar to chondrule 1. The silica-rich rim depleted in S relative to CI.

Oxygen isotope ratios for olivine and pyroxene in the core of chondrule 2 are in the range of composition observed in olivine and pyroxene in chondrule 1.

Discussion: Olivine in the chondrule 1 and 2 show a narrow compositional range and slightly enriched in FeO and depleted in Cr_2O_3 compared with other CR chondrites [3, 4, 5]. Pyroxene in the chondrule 1 and 2 shows also slightly enriched in FeO compared with the other CR chondrites [3, 4, 5]. Low- and high-Ca pyroxene in the chondrule 1 and 2 are depleted in Cr_2O_3 relative to other CR chondrites [1]. These observations suggest that Sahara 00182 suffered thermal metamorphism on the parent body at a temperature higher than other CR chondrites.

The bulk compositions in the silica-rich rims show that element patterns both of chondrule 1 and 2 are similar to other CR chondrites, but the abundance of S is much more enriched [1]. If we assume that the silica-rich rims formed by accretion of precursor silica-rich materials onto earlier-formed chondrule surfaces and subsequent melting of outer portions of chondrules, two mechanisms for the S enrichment can be considered: 1) the precursor silica-rich materials for Sahara 00182 experienced a weak heating relative to those of other CR chondrites before accretion on the chondrule surfaces, and 2) the silica-rich rims in Sahara 00182 formed via post-accretion melting at temperatures lower than those for other CR chondrites. The S distribution in the silica-rich rims in Sahara 00182 does not show any zoning: S abundance does not differ between inter and outer portions in the rims. This indicates that the S enrichment is indigenous. In addition, the composition and the texture of silica-rich rims in Sahara 00182 are similar to those of other CR chondrites. These observations therefore suggest that the precursor silica-rich materials for Sahara 00182 underwent pre-accretion heating at temperature lower than other CR chondrites.

References:

[1] Krot et al. (2004) *Meteoritics & Planet. Sci., 39,* 1931-1955. [2] Smith et al. (2004) *Meteoritics & Planet. Sci., 39,* 2009-2032. [3] Weisberg et al. (1993) *Geochimca et Cosmochimica.,Acta, 57,* 1567-1586. [4] Kallemeyn et al. (1994) *Geochimca et Cosmochimica.,Acta,l 58,* 2873-2888. [5] Bischoff et al. (1993) *Geochimca et Cosmochimica.,Acta, 57,* 1587-1603.

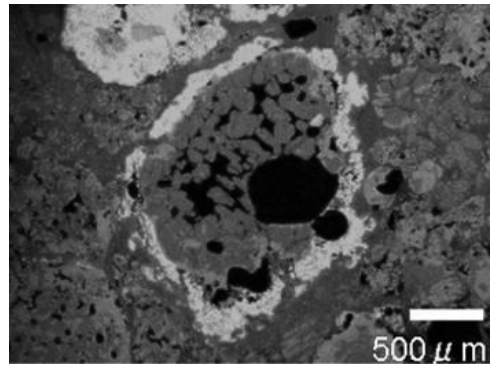

Fig. 1. X-ray elemental mapping in Si Kα for chondrule 1. The chondrule is surrounded by the silica-rich rim(white).

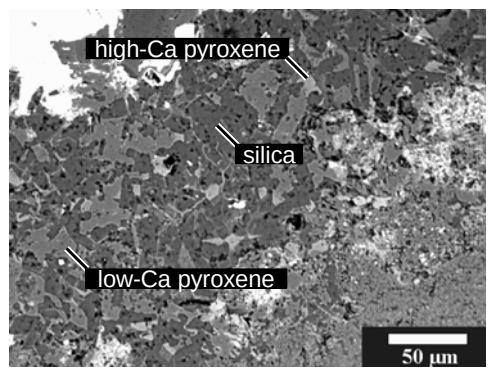

Fig. 2. BSE image in the silica-rich rim in chondrule 1. The silica-rich rim mainly consists of silica, low-Ca and high-Ca pyroxenes, and Fe, Ni-metal nodule.

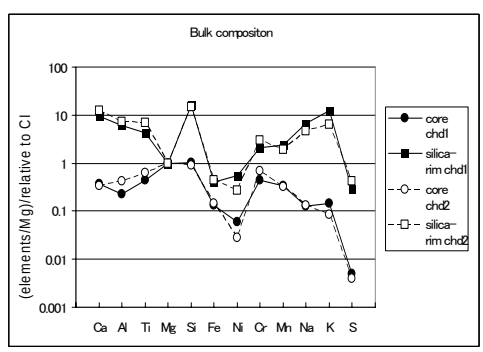

Fig. 3. Bulk compositions of the core and the silica-rich rim in chondrule 1 and 2 normalized to Mg and CI.