PETROGRAPHY OF QUEBRADA CHIMBORAZO 001 – A NEW CB_a CHONDRITE. T.E. Koch[1*], F.E. Brenker[1,2], A.N. Krot[2], M. Bizzarro[3]. [1]Goethe University Frankfurt, Altenhöferallee 1, 60438 Frankfurt am Main, Germany, [2]Hawai‘i Institute of Geophysics and Planetology, School of Ocean and Earth Science and Technology, University of Hawai‘i at Manoa, Honolulu, HI 96822, USA. [3]Centre for Star and Planet Formation, Natural History Museum of Denmark, Denmark. *koch@kristall.uni-frankfurt.

Introduction: The CB (Bencubbin-like) metal-rich carbonaceous chondrites are a rare group of meteorites [1]. It was first introduced by Weisberg et al. [2] after recognizing some mineralogical, isotopic and petrological similarities of the metal-rich chondrites Bencubbin, Weatherford, Hammadah al Hamra (HH) 237 and Queen Alexandra Range (QUE) 94411 paired with QUE 94627. Weisberg et al. suggested to classify these five meteorites in an new group called CB (for carbonaceous and Bencubbin) and listed the typical characteristics as (1) high metal abundances (60–80 vol% metal), (2) most chondrules have cryptocrystalline or barred textures, (3) moderately volatile lithophile elements are highly depleted, and (4) nitrogen is enriched in ^{15}N. Based on their petrologic characteristics, the CB chondrites are currently subdivided into two subgroups – CB_a (Bencubbin/Weatherford) and CB_b (QUE 94411/HH 237). The meteorite Quebrada Chimborazo 001 (QC 001) found in 2004 in Antofagasta, Chile most likely represents a new member of the CB_a subgroup and is subject of the study presented here.

Methods: The mineralogy and texture of QC 011 were studied using scanning and transmission electron microscopy (SEM, TEM) and electron probe microanalysis. In addition Raman spectroscopy was used to identify high pressure phases and their spatial distribution.

Results: The investigated polished thick section of QC 001 consists of magnesian non-porphyritic cm-sized chondrules and their fragments, Fe,Ni-metal+sulfide nodules and their fragments, and impact melt material (Fig. 1). The chondrules and chondrule fragments have skeletal olivine textures and consist of magnesian olivine laths ($Fa_{2–5}$, n = 5), low-Ca pyroxene ($Fs_{2–5}Wo_{0.5–1}$, 0.1–0.2 wt% TiO_2, 0.6–1.1 wt% Al_2O_3, 0.5–0.6 wt% Cr_2O_3, n = 8), high-Ca pyroxene ($Fs_{2–4}Wo_{40–50}$, 0.3–1.7 wt% TiO_2, 7.6–18.9 wt% Al_2O_3, 0.3–2.0 wt% Cr_2O_3, n = 5), and anorthitic mesostasis.

Shock melts composed of Fe,Ni-metal droplets crosscut some of the chondrule fragments. Small fragments of chondrules together with silicate melt droplets are embedded in metal at the metal-silicate boundaries. Further silicate shock melts form a network of high pressure veins throughout the metal (Fig. 1). The metal has a mean bulk composition of about 93.5 wt% Fe, 6.1 wt% Ni and 0.38 wt% P with highly variable Ni content. The metal grains show Ni-enrichment at the rim which decorates the grain boundaries and elucidate their equilibrated shape morphologies. In several regions, metal contains high abundance of sulfide droplets. Two types of sulfides were identified: (1) troilite blebs with a size of about 1–15 µm. These blebs show exsolution lamellae of daubréelite as it has already found in other CB chondrites [2]. Some of the lamellar sulfide grains contain small drops of Ni-rich metal. (2) The other type of sulfides is formed in irregular structures with a size of 10–60 µm and a troilite-like composition interstitial to metal grains. These troilite structures include rounded exsolution blebs of daubréelite and irregular shaped Ni-rich metals. Both types exist close to each other.

The impact melts often show a flowing texture (Fig. 1) and consist of Fe,Ni-metal+sulfides, and abundant and complex ferroan silicate droplets (in wt%: 42.5±1.0, SiO_2; 0.26±0.48, TiO_2; 3.6±0.3, Al_2O_3; 0.90±0.15, Cr_2O_3;17.1±3.3, FeO; 0.09±0.03, MnO; 33.1±3.6, MgO; 2.8±0.59, CaO; 0.24±0.07, Na_2O; n.d., K_2O; n = 24).

Raman analysis of silicate melt drops in metal yields wadsleyite, mostly within the core rimmed by olivine (Fig. 2). Detailed studies of chondrules show enstatite and majorite associations. The complex silicate melt droplets might also contain high pressure phases which are the subject of ongoing TEM studies.

Discussion: The meteorite is mineralogically very similar to the Bencubbin-like carbonaceous chondrites (CB_a) Gujba, Bencubbin, Weatherford, and MIL 05082 and 07411. Thus Quebrada Chimborazo 001 is a new member of the CB_a subgroup.

The shock level of QUE 94411, HH 237 and Bencubbin was considered as S2–S3 (5–20 GPa) due to its low degree of damage in olivine [3]. The equilibrated metals imply an enlarged period of equilibrium at higher temperatures at about > 1200 K [4,5] before the formation and intrusion of shock melted silica. The existence of wadsleyite core rimmed with olivine in silicate droplets may imply very rapid temperature and pressure decrease. Together with our findings of majorite we can conclude that pressure temperature during shock melting was similar to data obtained from CB_a chondrite Gujba with about 19 GPa and 2000°C [1].

References: [1] Weisberg M. K., Kimura, M. (2010) *Meteoritics & Planet. Sci.*, 45, 837–884. [2] Weisberg M. K. et al. (2001) *Meteoritics & Planet. Sci.*, 36, 401–418. [3] Meibom A. et al. (2005) *Meteoritics & Planet. Sci.*, 40, 1337–1391. [4] Weisberg M. K. et al. (1990) *Meteoritics & Planet. Sci.*, 25, 269–279. [5] Campbell A. J. (2001) *Geochim. Cosmochim. Acta*, 65, 163–180.

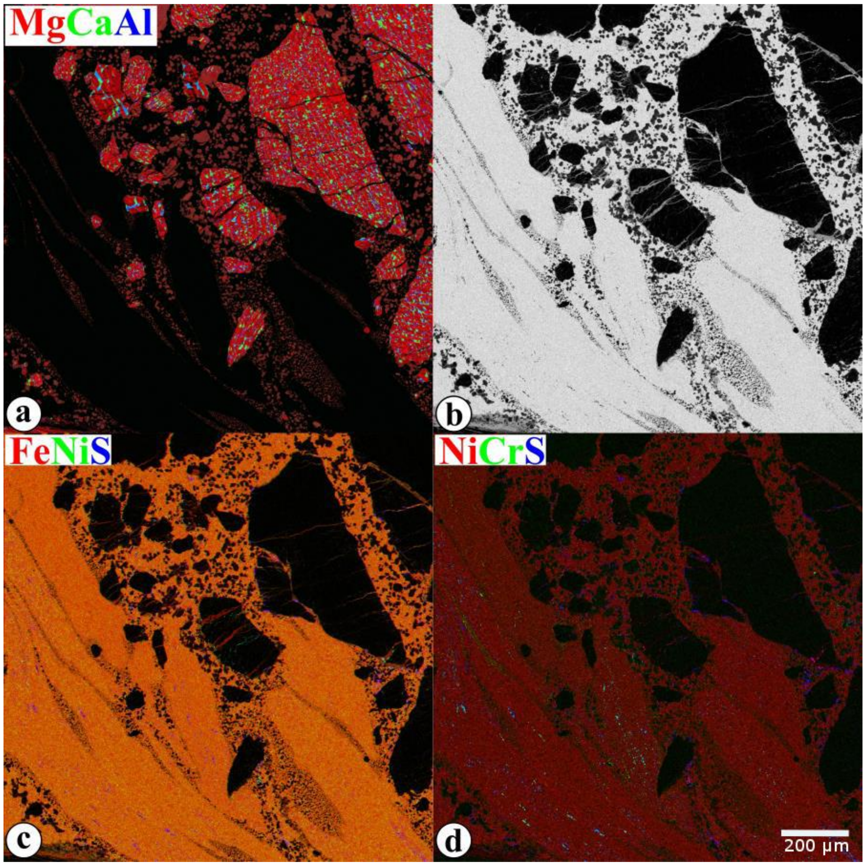

Fig. 1. Combined x-ray elemental maps in (a) Mg (red), Ca (green) and Al (blue), (c) Fe (red), Ni (green), and S (blue), and (d) Ni (red), Cr (green), and S (blue), and (b) BSE image of a CB_a chondrite Quebrada Chimborazo 001.

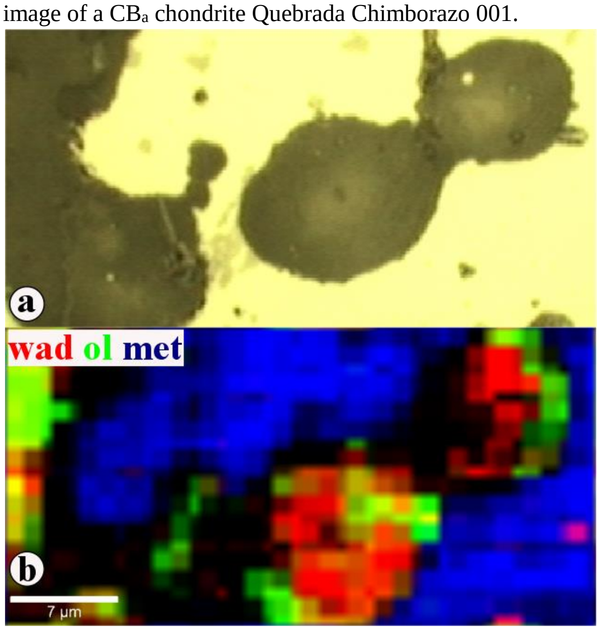

Fig. 2. (a) SE image of silicate melt droplets (dark grey) in metal (light gray). (b) Raman phase map. Wadsleyite (red), olivine (green), metal (blue).