CHARACTERIZATION AND QUANTIFICATION OF METALLIC AND MINERAL PHASES IN THE HIGHLY HYDRATED GROSVENOR MOUNTAINS 95577 CR1 CHONDRITE. M.Perronnet[1] and M.E. Zolensky[1], [1] NASA Johnson Space Center, 2101 Nasa road One, Building 31, Mail code KT, Houston, TX 77058. mperronn@ems.jsc.nasa.gov

Introduction: The Grosvenor Mountains 95577 chondrite has been first reported as a C2 chondrite consisting of large chondrules (up to 1.8 mm diameter) made up almost of serpentine [1].But after a petrological study [2] concluded that this sample was in fact the first known CR1 chondrite. Its petrology and O isotopic composition ($\delta^{18}O=6.32$ and $\delta^{17}O=2.83$ which plots close to the Renazzo CR chondrite) is coherent with other CRs but it would be the most hydrated of these. [2] noted that a remarkable replacement process, which preserved the textural integrity of the initial chondrite, changed olivine and pyroxene into serpentine within the chondrule, feldspar into Al-chlorite within the mesostasis and the metal into magnetite. Thus, by comparing this sample to a less altered CR, Renazzo, this would represent a unique opportunity to study the alteration processes on the CR parent asteroid [2]. Therefore, we decided to continue characterization of the mineralogy of the hydrous phyllosilicates and opaque phases. Using X-ray elemental maps and IDL image treatment software, we were able to estimate the proportion of each phase. These data will be used to constrain the physico-chemical conditions of the alteration process. The long-term objective is to apply this procedure to a series of CR chondrites with respect to increasing degree of aqueous alteration.

Analytical procedure: Two thick sections of GRO 95577 were prepared at NASA-JSC. Compositions of silicate minerals and opaque phases were determined using the JSC JEOL JSM-5910LV Secondary Electron Microscope (SEM) and the JSC Cameca SX-100 electron microprobe in WDS mode using appropriate silicate and metal standards. Operating conditions were 15 keV accelerating voltage with a 20 nA beam current and a 1 µm diameter spot.

Modal abundance analyses were carried out by X-ray elemental maps acquired with the EMPA at 20 keV accelerating voltage with a 40 nA beam current. The spot diameter is 1 µm and the dualtime is 30 ms. Four areas, whose sizes ranged from 1000*1000 pixel^2 to 1860*1860 pixel^2 were maped for Si, Mg, Fe, Ni, S, Al, Ca, Na with a resolution of 1 µm per pixel. The intensity of the signal in each pixel is accessible thanks to the IDL software. With respect to the intensity on the Fe, Ni, S, Al and Si maps, it was possible to distinguish the different metallic and mineral phases (

Figure 1). For each element, a range in intensity is attributed to each phase which was previously identified by SEM and EMPA. For each phase, once the range of signal intensity is defined on Fe, Ni, S and Al maps, IDL software is able to quantify the number of pixels which fulfill these intensity conditions and thus the surface percentage of each phase on the map.

Results: *Chondrules*. The outlines of chondrules are still visible but they now consist almost entirely of serpentine having an antigorite composition. Mesostasis has a chamosite composition. Four families of chamosite are defined with respect to their Fe content. No anhydrous silicates are observed. Unlike [2], we do not observe any large magnetite-rich chondrules but we do observe relics (67 µm mean) of kamacite. The blebs are quite often low-Ni (3.4 wt% Ni) but one bleb exhibits zoning, with the inner part being enriched in Ni (12.7 wt% Ni). Pyrrhotite and pentlandite are observed but “intermediate compositions” phases [e.g. 3] are predominant. Their mean composition is 51.7 wt% Fe, 33.7 wt% S, 11.7 wt% Ni, 2.13 wt% Si, 0.63 wt% Co and 0.14 wt% Cr. Within chondrules, huge calcite grains are present (533-640 µm) which enclose pentlandite, pyrrhotite and relics of antigorite. Rims around chondrules are well defined and consist of serpentine having a jenkisite composition (Fe-antigorite). Grains of framboidal magnetite, bleb of kamacite, pyrrhotite and intermediate sulfides are within the rims.

Matrix. Matrix is fine-grained and mainly consists of jenkisite. Sulfides (no bigger than 5 µm) and magnetite are visible. No anhydrous silicates are present.

Modal abundance analysis. In GRO 95577, magnetite accounts for 2.2%, blebs of metal for 3%, sulfides for 5.1%, calcite for 11.8%, antigorite in chondrule for 19.5%, chlorite mesostasis for 20%. Jenkisite rich matrix is the most important fraction and represents 38.5% of the map.

Discussion-Conclusions: Within chondrules, it is remarkable that the original Si,Mg composition of olivine and pyroxene is inherited by antigorite just as the Si,Al,Fe composition of feldspar mesostasis remains in chamosite. Assuming that Renazzo and GRO 95577 are related to one another, when comparing antigorite and chamosite compositions to olivine, pyroxene and mesostasis in Renazzo [4, 5], no obvious (Si,Al,Fe,Mg) elemental migration appears during the alteration. The proportion of chondrules, matrix and opaque phases of GRO 95777 and Renazzo can also be compared (Table 1) to better understand aqueous alteration. One first comment is that during this process, the proportion of these 3 main components is not drastically changed. Secondly, it is interesting to note that the proportion of matrix does not increase with increasing alteration. That is in good agreement with the fact that the texture and the outlines of chondrules are preserved. This alteration does not significant mechanical processing but must mostly have been a chemical process. In order to get a more representative modal analysis, we performed further X-ray maps whose results will be shown at the meeting.

Like in CM chondrites, Ni-Fe sulfides show considerable solid solution. As [3] noted, the fact that the intermediate sulfide phases have the same composition in chondrule rims and matrix requires similar alteration conditions. On contrary to the primitive CR chondrites, MET 00426 and EET 99177 [6], the abundance of calcite, the presence of magnetite and intermediate sulfides plus the relatively low microprobe analysis total support the high degree of aqueous alteration.

As a perspective work, TEM microchemical analyses of the phyllosilicates in the matrix and in the chondrules will allow us to refine their chemical composition and to get structural formula. Phyllosilicates are known to be good indicators of the physico-chemical conditions under which they are formed. Thus, our goal for the next months is to describe the phyllosilicates in a series of CR chondrites exhibiting the widest possible range of alteration, which will help us to further constrain the conditions under which the alteration occurred.

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Table 1: Vol% of the 3 main components of Renazzo and GRO 95577 CR chondrites. [1] includes Dark Inclusions, [2] antigorite + mesostasis+calcite.

	Renazzo[7]	Renazzo[5]	GRO 95577
Chondrule	51.1	49.6	51.3[2]
Matrix	41.9	41.4[1]	38.5
Opaque phases	6.1	8.1	10.3

Figure 1: X-ray elemental map (1000 * 1000 µm^2). 1 high-Ni kamacite, 2 kamacite, 3 pyrrhotite, 4 magnetite, 5 intermedite phases, 6 jenkisite rich matrix, 7 chamosite rich mesostasis, 8 antigorite, 9 calcite.