

AQUEOUS ALTERATION IN CR2 CHONDRITES. M.K. Weisberg^{1,2} and M.Prinz¹. (1) Dept. Mineral Sciences, Amer. Museum of Nat. Hist., New York, NY 10024. (2) Dept. Geology, Brooklyn College (CUNY), Brooklyn, NY 11210.

Introduction. The CR2 (Renazzo-type) chondrites are a group of six meteorites and includes Renazzo, Al Rais, MAC87320, Y790112, Y793495, and EET87770 (a paired group of 7). The classification CR was originally applied by McSween [1] to distinguish Renazzo and Al Rais from the other carbonaceous chondrites. Bulk chemical compositional data [2] support that Renazzo and Al Rais should be grouped separately, but that they may not belong to the same (CR) group because of differences in their volatile element abundances. However, petrologic studies of all the six CR chondrites and their oxygen isotopic compositions [3,4] indicate they are indeed related; differences in the bulk chemical properties of Renazzo and Al Rais may be a reflection of the high proportion of matrix in Al Rais. Aqueous alteration has been studied in the CI, CM, and CV chondrites, but little is known about alteration in the CR2 group. Brief descriptions of Al-, Fe-rich serpentines in Renazzo were given by Nelen et al. [5] and we described chlorite-like phases and serpentines in layered chondrules in Renazzo and Al Rais [6]. Here we report on an SEM/EMPA study of the phyllosilicates and carbonates in Renazzo, Al Rais and Y790112; further studies on the other CRs is in progress. The purpose of this study is to learn about the conditions and environments that existed during aqueous alteration of the CR chondrites, and how these conditions compare to those in other chondrite groups.

Phyllosilicates in CR chondrites occur: (1) in chondrule interiors (2) as rims on layered chondrules [6], and (3) as brown microspherules in chondrule cores and rims, and in the matrix. (1) In chondrule interiors the phyllosilicates are greenish to light brown in color and highly aluminous (10-15 wt.% Al_2O_3). They have variable FeO (20-30%) and MgO (10-20%) and may contain 10-15% H_2O (calculated by difference). Their compositions are similar to those of chlorites, but most appear to be mixtures, on the submicrometer scale, of two or more types of phyllosilicates; they may be chlorites mixed with smectites and/or relicts of anhydrous silicates that survived the alteration event. They appear to be replacement products of the feldspathic mesostasis typically found in anhydrous chondrules, with olivine, pyroxene, FeNi and sulfides contributing Fe and Mg. These Al-rich phyllosilicates have not been reported in any other chondrite group. Some chondrules have a mesostasis that is similar in composition to the serpentine-rich rims and microspherules. (2) Many CR chondrules are concentrically layered and a shell of phyllosilicates forms the outermost layer in many of these chondrules. These shells are typically green to light brown in color and compositionally appear to be Fe-rich serpentine which may be mixed with smectite. They contain 32-42% SiO_2 , 2-5% Al_2O_3 , 22-33% FeO, and 14-21 % MgO. (3) Brown microspherules (5-20 μm in diameter) occur in chondrule cores, within the phyllosilicate-rich layers surrounding chondrules, and are found unassociated in the matrix and clinging to the outermost edges of chondrules. These microspherules are compositionally similar to the phyllosilicate rims on chondrules and may also be mixtures of serpentine and smectite minerals. Although the compositions of phyllosilicate rims and microspherules overlap, the brown microspherules tend to be more Mg-rich. In comparison to other chondrite groups, serpentines in CR chondrites are most similar to those described in the Nogoya CM2 chondrite [7], but none are as magnesian as the Mg-rich serpentines described in CM2 chondrites or the serpentines and saponites described in CI and CV chondrites [7,8,9,10] (Fig. 1).

Carbonates in CR chondrites have been reported by Fredriksson et al. [11] and they found Ca-carbonates with varying amounts of Mg, Fe, and Mn. The carbonates occur (1) in the matrix and in matrix lumps, (2) in CAI's and rarely in chondrule cores, and (3) as the outermost shell of some layered and non-layered chondrules. Ca-carbonate rims on chondrules were found in all three CR chondrites studied and have not been reported in any other chondrite group. Most Ca-carbonates are anhedral with no recognizable rhombohedral form. Some of the matrix clasts do contain some twinned, rhombohedral calcite, but these are rare. The Ca-carbonates in CR chondrites range from nearly pure to having up to 7.3% FeO, 3.1% MgO and 1.9% MnO; FeO may be an overestimate due to intergrowths of magnetite with the carbonate that are too fine to be

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resolved with a 1-2 μ m electron beam. Carbonates having similar compositions have not been described in any other chondrite group. CI chondrites contain nearly pure Ca-carbonates with up to 0.19% Sr [12], and those in CM are also nearly pure [13]. The Ca-carbonate rims on chondrules may be the result of fluids flowing around chondrule-matrix contacts and depositing the carbonate. However, it should be noted that only few chondrules contain these rims of Ca-carbonate and those with broken surfaces contain these rims only on the original curved surface of the chondrule and not the angular broken portion. Thus, either Ca-carbonate was selectively deposited on these chondrule rims or the carbonate formed prior to breakage of the chondrule and final lithification of the host chondrite.

Discussion and Conclusions. (1) The assemblages and compositions of the phyllosilicates in the CR chondrites are similar, and they differ from those in CI, CM and CV chondrites. Thus, the history of aqueous alteration that they record differs from that of the other chondrite groups. (2) Carbonates in CR chondrites also differ compositionally from those in other chondrite groups. (3) Ca-carbonate rims on chondrules are found only in CR chondrites. (4) The carbonate rims occur only on curved, and not on broken, surfaces of chondrules, suggesting that the carbonate formed prior to breakage of the chondrule and the final lithification of the host chondrite. (5) During alteration the CR chondrites must have experienced temperatures and water/rock ratios that differed from those of other chondrite groups and assuming aqueous alteration occurred on the parent body, it probably took place in an unconsolidated or poorly consolidated regolith.

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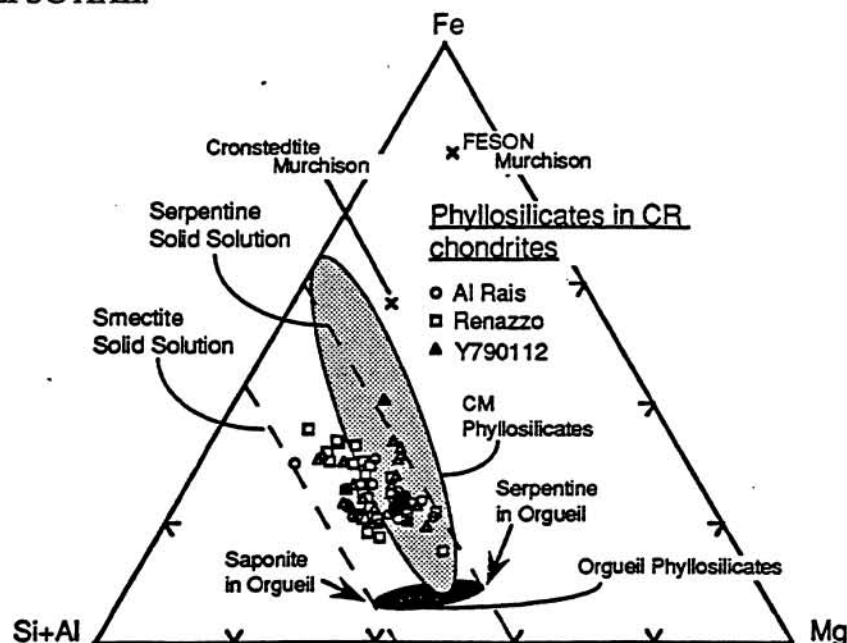


Fig. 1 Electron microprobe analyses (atomic%) of phyllosilicates in CR chondrites.