PETROLOGIC–TOMOGRAPHIC STUDY OF METAL IN THE CR CHONDRITES. M. K. Weisberg[1,2], D. S. Ebel[2], H. C. Connolly Jr.[1,2], J. S. Boesenberg[2] and D. Castellano[1] (1) Department of Physical Sciences, Kingsborough College of the City University of New York, Brooklyn., NY 11235. (2) Department of Earth and Planetary Sciences, American Museum of Natural History, NY, NY 10024.

Introduction: The CR chondrites are widely considered to be among the most primitive chondrite groups despite various degrees of hydration alteration suffered by their constituent components. One of the intriguing components in the CR chondrites is the metal. It constitutes up to 7.5 vol. % of CRs [1] and has a solar Ni-Co ratio, consistent with an origin by nebular condensation [1, 2]. However, petrologic and trace element data suggest formation of CR metal by reduction during chondrule formation [3] or devolatilization of iron sulfides [4]. Based on trace siderophile elements, formation of CR metal by direct nebular condensation has been excluded [5]. Metal in chondrule rims may have formed by vaporization of interior metal followed by recondensation onto the rim [3]. To better understand metal formation, we combined computed X-ray microtomography and petrology to study metal abundances in chondrules in the Renazzo CR chondrite fall.

Results: We generated tomographs of a 12mm x 6mm x 6mm sample of Renazzo, using the GSE-CARS APS beam line at Argonne National Lab. From the tomographs we studied three chondrules that could be viewed in entirety. Two of these are silicate-rich chondrules containing large (~600 µm-size) metal globules in their cores and smaller metal globules in the rims. The third one is an isolated ~800µm metal sphere in the matrix. We determined modal abundances (vol.%) of metal in the cores and rims of the two silicate chondrules. Their cores contain up to 18 vol.% metal and the rim metal constitutes an additional 5 vol.% of the chondrule. Also, we studied metal in thin sections of several CR chondrites. We found large metal chondrules, similar in size to the silicate chondrules and identified small (2-3) µm metal grains in amoeboid olivine aggregates (AOAs). These AOAs consist of forsterite surrounding nodules of anorthite, diopside and Mg-Al spinel. In some cases, AOA metal appears to be included within the olivine.

Discussion: Model(s) for the formation of CR metal must account for the high abundance of metal in the chondrules, occurrence of large metallic chondrules and presence of metal in refractory inclusions. Formation of some metal by reduction of FeO in silicates requires that the chondrule precursors were highly oxidized and contained high abundances of Fe. Some large isolated, metal chondrules may have formed by centrifugal ejection of metal from chondrule cores [4]. However, this may require unusually large parent chondrules that have not been observed in the CR chondrites. Some metallic chondrules may have formed by melting of metal precursors that condensed from the nebula. If CR metal formed by devolatilization of sulfides, chondrule precursors must have included high abundances of FeS. The AOAs that contain metal are aggregates of olivine and refractory nodules, and do not appear to have ever been molten. The formation of metal in the AOAs by reduction would require that the olivine was initially FeO-bearing. Another possibility is that the metal in the olivine is condensate that acted as nuclei for olivine growth. We conclude that the origin of metal in the CR chondrites is not completely understood and may require a variety of processes including reduction, vaporization, recondensation, and nebular condensation cannot be entirely excluded.

References: [1] Weisberg M. K. et al. (1993) GCA 57, 1567-1586. [2] Grossman L. and Olsen E. (1974) GCA 38, 173-187. [3] Connolly H. C., Jr., et al. (2001) GCA 65 163-180. [4] Zanda B. et al. (2002) LPSC XXXIII. [5] Humayun M. et al. (2002) LPSC XXXIII.