VARIABLE DEGREES OF LOW-TEMPERATURE ALTERATION IN TYPE-II CHONDRULES IN THE CR CARBONACEOUS CHONDRITES, D. L. Schrader¹, D. S. Lauretta¹, and H. C. Connolly Jr.¹,²,³ ¹Univ. of Arizona, Lunar and Planetary Laboratory (LPL), Tucson, AZ 85721, USA, ²Dept. Physical Sciences, Kingsborough Community College of CUNY, USA and Dept. Earth and Environmental Sci., The Graduate Center of CUNY, ³Dept. Earth and Planetary Sciences, AMNH Central Park West, New York, N.Y. 110024, USA. Email: schrader@lpl.arizona.edu

Introduction: Determining the degree and type of alteration among the CR chondrites is essential to understanding volatile element evolution in the early Solar System [1]. Metal and sulfides are important to study as they respond rapidly to alteration as either gas-solid or gas-metallic melt (pre-accretion), liquid-solid (post-accretion), or processes occurring on Earth. Sulfides are ubiquitous within CR chondrite type-II chondrules [2,3] and matrix. Metal is common in type-I chondrules and sulfides are rare. Detailed studies of these components constrain the alteration history recorded in the CR chondrites.

Procedure: We analyzed thin sections of Al Rais, the EET grouping (87770, 92011, 92042, and 96259), GRA 95229, GRO 95577, GRO 03116, the LAP grouping (02342 and 04720), MAC 87320, MET 00426, PCA 91082, QUE 99177, Renazzo, Shişr 033, and Y-793495 using optical microscopy, elemental X-ray mapping techniques, SEM, and EMPA. A-881595, Gao-Guenie (b), GRA 06100, and NWA 801 are currently being studied.

Discussion: Sulfides in type-II chondrules likely formed by high-temperature gas-solid reactions and then underwent low-temperature alteration [3]. By investigating the composition of opaque phases within type-II chondrules and matrix, at least two populations of type-II chondrules in the CR chondrites have been recognized. The least-altered population of chondrules are identified by the presence of metal, rare magnetite, and a pentlandite/troilite ratio <1. It includes those in the EET and LAP groupings, GRA 95229, MAC 87320, MET 00426, PCA 91082, and QUE 99177. The most heavily-altered population of chondrules are characterized by the presence of magnetite, rare metal, and a pentlandite/troilite ratio >1. Overlap is observed, potentially due to brecciation and/or local variations in alteration intensity, which may suggest a continuum between the two populations. Some opaque assemblages in the matrix show a similar range of alteration as the type-II chondrule opaques, suggesting a common origin. Due to complete hydration of silicates in GRO 95577 [4] and extensive weathering in GRO 03116, grouping is not clear at this time.

We have identified varying degrees of low-temperature alteration among the type-II chondrules in the CRs. We are working to constrain if the low-temperature alteration occurred pre- or post-accretion, or a combination. Other indicators of post-accretion aqueous alteration such as the matrix/chondrule ratio, the average Ni content of sulfides, and bulk-chondrite volatile element abundances are being investigated. A comparison of alteration signatures in type-II chondrules to type-I chondrules and matrix is underway.