**CR2 CHONDRULE ORIGIN: OXYGEN ISOTOPES, REDOX, AND THE ROLE OF ICY BODIES IN THE DISK.**

H. C. Connolly Jr[1] and Gary. R. Huss[4]. [1]Kingsborough Community College of CUNY, Brooklyn, New York 11235 USA. [2]Lunar and Planetary Laboratory, Tucson, AZ USA [3]American Museum of Natural History, New York, New York USA. E-mail: hconnolly@kingsborough.edu. [4]Hawai'i Institute of Geophysics and Planetology, University of Hawai'i at Manoa, Honolulu, HI.

Chondrules in CR2 chondrites have diverse O-isotope compositions. CR2 type-I (FeO-poor) chondrules form a single group lying below the TF line and to the left of the CCAM line [1]. CR2 type-II (FeO-rich) chondrules form three distinct groups: (1) a group that overlaps the heavy end-members of type-I chondrules, (2) one on the CCAM line near the intercept with the TF line and, (3) one within the field of ordinary chondrite chondrules [2,3]. As a general rule, type-I chondrules are $^{16}$O-rich compared with type-II chondrules, but no petrographic or geochemical feature other than their broad designation of type-I and type-II is correlated with their O-isotopes. The general correlation between the redox conditions and O-isotope composition strongly suggests that a process or set of processes may have controlled both characteristics of CR2 chondrules.

A set of processes that may account for the above observations is shelf-shielding followed by migration of $^{17,18}$O-rich icy bodies into the chondrule-forming region(s) before transient heating. Isotope-selective dissociation of CO molecules due to absorption of UV photons can occur in regions where the photons that dissociate C$^{17}$O and C$^{18}$O penetrate more deeply into a body of gas than photons that dissociate C$^{16}$O due to the lower column density of C$^{17}$O and C$^{18}$O. The result is preferential release of $^{17}$O and $^{18}$O from CO molecules followed by recombination into $H_2O$, producing water enriched in heavy oxygen [4-6]. Beyond the snow line, the $^{17,18}$O-rich water freezes onto mineral grains to form ice mantles, leaving the gas enriched in $^{16}$O. The result is two distinct O-isotopes reservoirs. The ice-covered grains then accrete into larger bodies, meters to 10's or 100's of meters in diameter. These bodies move inward with time in the disk [7,8].

Evidence from chondrites suggests that local regions of the disk evolved from $^{16}$O-rich to $^{17,18}$O-rich. For example, relict forsterite grains with O-isotope compositions similar to type I chondrules within type II's suggests that redox conditions evolved from near solar, when type I chondrules and the relict grains formed, to orders of magnitude more oxidizing, when type-II chondrules formed.

In our model, type-I chondrules formed when significant $H_2O$ vapor had migrated outwards past the snow line, leaving the gas in the inner Solar System enriched in $^{16}$O and a low $fO_2$, ideal for production of type-I chondrules. Migration of icy bodies into the chondrule-forming region(s) of the inner Solar System occurred after type-I chondrules formed. During additional transient heating events, icy bodies were heated and $H_2O$ vapor was added to the ambient gas, increasing the $^{17,18}$O abundances and the $fO_2$ to well above solar, which is when type-II chondrules formed.

**References:** [1] Krot et al., 2006, *Geochim. Cosmochim. Acta.* 767. [2] Connolly et al., 2008 *Lunar. Plant. Sci. Conf.* #1675. [3] Connolly and Huss 2009, *Geochim. Cosmochim Acta*, submitted. [4] Theimens M. 1996 *Chondrites and the Protoplanetary Disk*, 107. [5] Young et al., 2008 *Oxygen in the Solar System, Reviews in Mineralogy*, 187. [6] Yurimoto et al., 2008 *Oxygen in the Solar System, Reviews in Mineralogy*,141. [7] Cuzzi and Zahnle, 2004 *ApJ* 490. [8] Ciesla 2008 *Science* 613.