CV Chondrites: More than One Parent Body

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Introduction: CV chondrites have been classically divided into reduced (CV_{Red}) and oxidized (CV_{Ox}) sub-groups, based on a number of mineralogical features, the Ni content of sulfides and the abundance of Fe,Ni metal [1]. The oxidized sub-group has been further divided into Allende- (CV_{OxA}) and Bali- (CV_{OxB}) type, based on a combination of chemical and petrographic criteria [e.g., 2, 3]. These three sub-groups are interpreted as coming from a single parent body, with a common protolith affected by significant parent body fluid-assisted metasomatism occurring at different temperature and/or redox conditions [2,4]. CK chondrites have been interpreted as coming from a more thermally metamorphosed (deeper) part of the same CV parent body [e.g., 5,6], but this interpretation has been recently challenged [7]. In this work we will argue that although CV_{OxA} and CV_{OxB} are likely to originate from a single parent body, CV_{Ox} and CV_{Red} originate from two different parent bodies.

Results: We investigated a suite of 50 CV chondrites. The main dataset, composed of the 30 meteorites (7 falls and 23 finds, mostly from Antarctica) whose thermal metamorphism and aqueous alteration have been characterized in details [8], is completed by 20 NWA meteorites. For all these meteorites, we determined the sub-group (Ox_A, Ox_B or Red) by combining three proxies (the average Ni content of sulfides, the Fe,Ni metal abundance, and magnetic parameters) which allow for a clear separation of the three sub-groups. We then estimated their matrix abundance (by image analyses and point counting), and measured their chondrule apparent diameters (by optical microscopy, over 2000 chondrules measured). For a subset of samples, we measured the bulk oxygen isotopes composition by laser fluorination coupled with mass spectrometry.

Discussion and conclusions: Matrix abundances and the distribution of chondrule apparent diameters are identical for CV_{OxA} and CV_{OxB} chondrites but significantly different between CV_{Ox} and CV_{Red} chondrites. These robust and simple petrographic indicators can be interpreted in two different ways: a different stratigraphic position of CV_{Ox} and CV_{Red} within a single parent body, or provenance from two distinct parent bodies. A different stratigraphic position would imply contrasted metamorphic temperatures with the deeper group being metamorphosed to higher temperatures. This is not observed, as both CV_{Ox} and CV_{Red} meteorites span the whole range of type 3 metamorphic subtypes [6]. Therefore, we conclude that CV_{Ox} and CV_{Red} meteorites originate from two different parent bodies. This claim is also supported by slightly overlapping but distinct oxygen isotopes compositions. The existence of CV_{Ox} clasts in Vigarano CV_{Red} regolith breccia [9], often used as an evidence for a single parent body is not a decisive argument as xenolithic clasts from different meteorite groups are found in a number of meteorites. For instance, several ordinary chondrites contain cm-size clasts from another ordinary chondrite group [e.g., 10], and because ordinary chondrites are usually studied in much less details than CV chondrites more such examples have been probably overlooked.

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