PRESOLAR CHROMITE IN ORGUEIL.

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Introduction: We have previously reported the discovery of presolar Cr-rich oxide ($MgAlCrO_4$) grains in the Orgueil meteorite [1, 2]. Continued searches of our Orgueil residue have revealed several iron chromite grains with unusual O isotopic compositions, indicating that they are preserved stardust. These results indicate that chromite condenses around some O-rich stars, contrary to predictions of equilibrium condensation calculations.

Methods and Results: The Orgueil acid residue has been described previously [1]. About 2,700 1–5 μm O-rich grains were automatically analyzed for their O isotopic ratios with an ims-6f ion probe [3]. Of these, six grains were identified as presolar grain candidates. SEM-EDS identified five of these as chromite ($FeCr_2O_4$) with minor amounts of Mg and Al and the sixth as Al_2O_3 with minor Mg. The grains range from 1 to 4 μm in diameter. Four of the chromite grains were reanalyzed by NanoSIMS, confirming the 6f results. In contrast to other known presolar oxide and silicate grain types, the chromites are unusual in that they show a relatively limited range of compositions ($\delta^{17}O$=200—350‰, $\delta^{18}O\approx0$‰). The Al_2O_3 grain has a typical ^{18}O-depleted Group 2 signature [4]. Based on the chromite/Al_2O_3 ratio, we estimate the abundance of Orgueil presolar chromite as ~50ppb.

Discussion: The O isotope ratios of the unusual chromite grains are consistent with dredge-up of CNO-cycle processed material in red giant stars of ~1.25$M_\odot$ and slightly super-solar metallicity [5]. However, chromite is not expected as a major circumstellar condensate in such stars. Thermodynamic equilibrium models predict that as an O-rich stellar outflow cools from high T, both Fe and Cr condense into a metallic alloy, not as oxides [6, 7]. Chromite can possibly condense before metal under very oxidizing conditions [8], but this is not expected for low-mass stellar outflows. The existence of presolar Cr-rich spinel [1, 2] and presolar Fe-rich silicates [9] suggests that Fe and Cr can in fact condense into oxides in stellar outflows, likely indicating non-equilibrium conditions during circumstellar dust formation. Perhaps the present grains formed originally as mechanical mixtures of Cr-rich metal grains and spinel with subsequent annealing converting the assemblages to Mg, Al-bearing chromite. In any case, the restricted isotopic range of the grains suggests that they might have formed around a single type of star and thus chromite might not be a common circumstellar condensate. NanoSIMS measurements of Mg-Al, Cr and Fe isotopes in these unusual grains are planned for the near future. Resolving ^{54}Cr from ^{54}Fe will probably require RIMS measurements, however.

References: [1] Nittler L. R. and Alexander C. M. O'D. 2003. *Meteoritics and Planetary Science,* 38*:* A129 (Abstr.). [2] Zinner E. K., et al. 2005. *Geochimica Cosmochimica Acta,* in press. [3] Nittler L. R. and Alexander C. M. O'D. 2003. *Geochimica Cosmochimica Acta,* 67*:* 4961-4980. [4] Nittler L., et al. 1997. *Astrophysical Journal,* 483*:* 475-495. [5] Boothroyd A. I. and Sackmann I.-J. 1999. *Astrophysical Journal,* 510*:* 232-250. [6] Lattimer J. M., et al. 1978. *Astrophysical Journal,* 219*:* 230-249. [7] Lodders K. 2003. *Astrophysical Journal,* 591*:* 1220-1247. [8] Palme H. and Fegley B., Jr. 1990. *Earth and Planetary Science Letters,* 101*:* 180-195. [9] Nguyen A. N. and Zinner E. 2004. *Science,* 303*:* 1496-1499.