CHROMIUM ISOTOPE SYSTEMATICS OF MAIN GROUP UREILITES AND THE DIAMOND-BEARING UNGROUPED ACHONDRITE NORTHWEST AFRICA 12969.

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Introduction: Ureilites are highly depleted peridotites with a relatively high carbon content of ~3 wt. % and are thought to sample the mantle of a planetary embryo with a diameter of ~690 km [1] to a Mars-sized body [2]. Despite representing remnants of a large differentiated body, ureilites are unequilibrated in their O isotopic composition that correlates with Mg#. The variations of O isotopes [3] remain enigmatic but may relate to mixing of different chemical and isotopic reservoirs during accretion (e.g. [1,4]). In order to better understand the variations of nucleosynthetic isotope anomalies in main group (MG) ureilites (e.g. Mo and Cr [5,6]), ^{54}Cr isotopes were analysed in WR and acid-leachates. In addition, the short-lived ^{53}Mn-^{53}Cr system ($t_{1/2}$ = 3.7±0.4 Ma) is applied to obtain internal and external isochrons to constrain the temporal evolution of MG ureilites. Chromium isotope systematics were also analysed in the extremely magnesian-rich (Mg#=99), diamond-bearing ungrouped achondrite Northwest Africa (NWA) 12969 [7], to constrain the closure of the ^{53}Mn-^{53}Cr system in NWA 12969 and to identify genetic links (if any) to other meteorite groups in ε^{54}Cr-Δ^{17}O space.

Samples and Method: Whole-rock fragments from a suite of MG ureilites (type: olivine-pigeonite and augite-bearing [8]) and NWA 12969 were crushed in an agate mortar and digested in conc. HNO_3+HF for ca. 60 h using Parr® bombs at 190°C. Additionally, chromite bearing-ureilites were sequentially digested with acids of increasing strengths and processed as described in [9]. Digested WR samples and acid-leachates were split into two aliquots to determine (1) element concentrations of Cr, Mn and Fe, and (2) Cr isotope compositions. The second aliquot from each sample was purified by a three-step cation-anion exchange chromatography as described in [10,11] and was loaded onto outgassed Re-filaments with activators. Chromium isotopes were measured along with the terrestrial standard NIST SRM 979 on a Thermal Ionization Mass Spectrometer (TIMS) at the University of Bern.

Results and Discussion: The ε^{54}Cr of MG ureilite WR samples range from -0.93 to -0.64 and do not strongly correlate with the Mg# in olivine cores. The ε^{54}Cr value links the MG ureilites to the non-carbonaceous (NC) reservoir and potentially represents a spatial endmember. The ungrouped achondrite NWA 12969 is on the high ε^{54}Cr-side of the MG ureilite range and plots in the ureilite field when combined with the Δ^{17}O data from [12]. The ^{55}Mn/^{52}Cr ratios of olivine-pigeonite ureilites range from 0.38 to 0.77, while augite-bearing ureilites show a broader range up to 1.59, and correlate with ε^{53}Cr. NWA 12969 has an anomalously high ^{55}Mn/^{52}Cr ratio of 2.73. An external isochron of bulk MG ureilites, combined with data from [6,13] postdates the WR isochron reported in [6] by more than 4 Ma. The discrepancy might be related to the small variation of ^{55}Mn/^{52}Cr and the accompanying analytical uncertainty of the MG ureilites selected in [6], while the younger age of this study is essentially caused by augite-bearing ureilites with high ^{55}Mn/^{52}Cr ratios. Ages of internal isochrons of chromite-bearing ureilites constrained by acid-leachates range from 3-5 Ma after the formation of CAI when anchored to D'Orbigny angrite [14,15,16]. The ungrouped achondrite NWA 12969 does not plot on the external isochron of this study, and hence indicates that the isotopic closure of the ^{53}Mn-^{53}Cr system in NWA 12969 was not contemporaneous with that in MG ureilites. Assuming both NWA 12969 and MG ureilites formed from a chondritic reservoir, the isochron of NWA 12969 intersects the bulk MG ureilite isochron at a chondritic ^{55}Mn/^{52}Cr ratio and yields a model age of ~2 Ma after the formation of CAI when anchored to D'Orbigny angrite.

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