Rb-Sr AND Sm-Nd ISOTOPE SYSTEMATICS OF SHERGOTTITE NWA 856: CRYSTALLIZATION AGE AND IMPLICATIONS FOR ALTERATION OF HOT DESERT SNC METEORITES.
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Introduction: The shergottite NWA 856 was discovered in April, 2001 in Morocco [1, 2]. This shergottite is not paired with other shergottites discovered in northern Africa. Mineralogically, it is an olivine-free basalt and primarily consists of < 0.5 centimeter-size plagioclase laths converted to maskelynite, and up to 1.2 centimeter-sized acicular pyroxenes (augite and pigeonite) [1,3]. Minor phases typical of shergottites are present including Fe-Ti oxides, chromite, pyrrhotite, phosphates, and silica glass. Visual evidence for terrestrial alteration, primarily carbonate, has been only observed near the fusion crust and within cracks.

Supporting evidence suggesting that terrestrial weathering is very minor comes from the concentrations of large ion lithophile elements such as Cs, Ba, Sr, and U, that are strongly mobile in the terrestrial weathering environment. Jambon et al. [3] showed that element plots such as Ba versus La, and Sr versus Nd, NWA 856 falls on variation lines for non-desert shergottites, whereas Dhofar 019 and DaG 476 plot off the lines and show strongly elevated Ba and Sr contents. Hence this meteorite appears to be the least weathered of the hot desert SNC meteorites discovered to date [3], making it a suitable candidate for precise geochronological studies.

Major and trace element concentrations in NWA 856 indicate that it belongs to a group of basaltic shergottites that includes Zagami, Shergotty, and Los Angeles, and possibly the picrite NWA 1068 [3,4]. NWA 856 has a normalized REE pattern that is identical to these four, and the REE concentrations are intermediate between Los Angeles (higher concentrations), Shergotty, and Zagami (both lower concentrations). The Mg # (molar Mg/Mg+Fe) of NWA 856 is 0.42, which is intermediate between Los Angeles (0.20) and Zagami (0.46), but similar to shergotty (0.40) [3]. These relationships are consistent with an origin for NWA 856 via fractional crystallization from a melt that was also parental to the foremetioned shergottites.

In order to draw further comparisons to the basaltic shergottites and SNC meteorites as a whole, and to assess the origins of the variability of shergottite ages and compositions, we have began a detailed Rb-Sr and Sm-Nd isotopic investigation of NWA 856. It is important to evaluate whether the combined major element, trace element, and isotopic variability of these rocks can be explained by crustal contamination of a single mantle source, or whether multiple mantle sources are necessary, or if a complex hybrid of these two models is required. Each of these scenarios will result in different consequences and implications for the dynamic evolution of the Martian interior over Solar System history.

In this abstract, we present the initial Rb-Sr and Sm-Nd isotopic data and discuss their implications to shergotttie genesis. Additional Rb-Sr and Sm-Nd isotopic data will be added by the time of presentation.

Analytical Techniques: An aliquant sample of 0.340 g was used for Rb-Sr and Sm-Nd isotopic studies at JSC from the interior of the meteorite. The sample was carefully crushed and sieved to <149 μm. An amount of this sample of 0.086 g was split into 3 whole rock portions. The remainder of the sieved portions were further sieved to remove particles finer than 74 μm. The split containing 149 μm to 74 μm particles was then put through magnetic separation, while the <74 μm particles underwent density separation, to obtain plagioclase and pyroxene-rich separates. One whole rock portion and the mineral separates underwent variable leaching in 2N HCl and dilute HF to remove any terrestrial alteration present. Both acid residues (r) and acid-leachates (l) are, and will be analyzed.

Rb-Sr results to present: The Rb-Sr results obtained so far are shown in Figure 1. The Rb-Sr isotopic systematics for this meteorite has been weakly disturbed, most likely by terrestrial alteration. A reference isochron of 150±32 Ma is shown in Figure 1 for the leached residue WR (whole rock), Plag (plagioclase), and Px (pyroxene) seperates. The two pyroxenes were leached in HCl and HF, respectively. All four acid residue portions plot close to the reference isochron. The unwashed and leachate whole rock portions lie below the reference isochron and point towards the modern seawater value of $^{87}Sr/^{86}Sr$ of ~0.7090. This indicates that like other hot desert SNC meteorites, NWA 856 has undergone terrestrial alteration, although not as severe as others such as Dhofar 019, DaG 476, Los Angeles, and NWA 1068 [3-9].

The calculated initial $^{87}Sr/^{86}Sr$ for the reference isochron at 150 Ma is 0.72214+20. This initial $^{87}Sr/^{86}Sr$ is similar to those for Zagami, Shergotty, NWA 1068, and Los Angeles [5, 10-14].

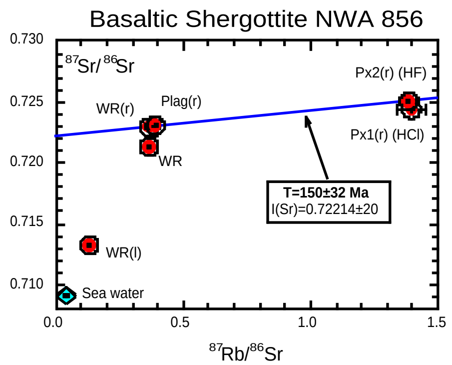

Figure 1. Rb-Sr isotope systematics for NWA 856.

Sm-Nd results to present: The Sm-Nd results obtained so far are shown in Figure 2. In contrast to the Rb-Sr systematics, the Sm-Nd isotopic systematics for this meteorite so far obtained do not show evidence for terrestrial alteration. An isochron of 186±24 Ma is shown in Figure 2 for an unleached WR, a leached residue WR(r), and two Px seperates leached in HCl and HF, respectively. The unwashed whole rock lies on the isochron. This is consistent with the suggestion that although NWA 856 has undergone terrestrial alteration, its Sm-Nd isotopic systematics were not affected as severely as the other hot desert SNC meteorites, it at all [3-9].

The calculated initial ε_{Nd} for the isochron at 186 Ma is -6.7±0.2. As with the initial $^{87}Sr/^{86}Sr$, this ε_{Nd} overlaps those for Zagami, Shergotty, NWA 1068, and Los Angeles [5,6,10-13].

Discussion and Conclusions: The combined Rb-Sr and Sm-Nd isotope systematics of NWA 856 confirms a direct genetic relationship of this meteorite with Zagami, Shergotty, Los Angeles, and NWA 1068 as previously proposed [1,3]. The ages of 150±32 and 186±24 Ma obtained from Rb-Sr and Sm-Nd isotopic systematics, respectively, overlap the ages obtained by these isotope systems for Zagami, Shergotty, NWA 1068, and Los Angeles, which range from 150 to 186 Ma [5,6,9-15]. The initial $^{87}Sr/^{86}Sr$ of 0.7221±2 and of -6.7±0.2 for NWA 856 overlap the range in initial $^{87}Sr/^{86}Sr$ of 0.7214 to 0.7226 and initial ε_{Nd} of -5 to -8 of these shergottites.

On the basis of their compositional similarities, these five SNC's and their paired siblings form a distinct shergottite subgroup. In comparison to other shergottites, nahklites, and Chassigny, the Sr and Nd isotopes indicate that their source regions had long term superchondritic Rb/Sr and subchondritic Sm/Nd. Models previously proposed for these enriched compositions call for either assimilation of early formed crust (i.e. ~4-4.5 Ga), or partial melting of a mantle source containing late stage liquids from an early formed magma ocean, both of which would be enriched in Rb/Sr and Sm/Nd (e.g. [5, 15-18]). At present, distinguishing between these two scenarios has been difficult, as many of the compositional consequences of each are similar. We will consider these contrasting scenarios using the isotopic data of NWA 856 once our results are finalized for this presentation.

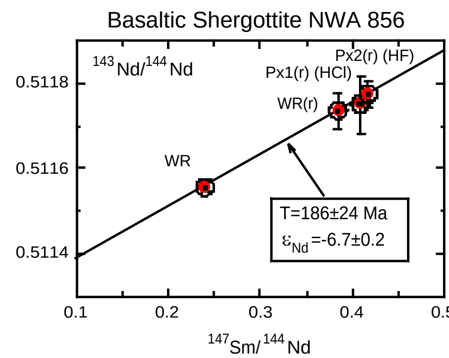

Figure 2. Sm-Nd isotope systematics for NWA 856.

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