THE TRACE-ELEMENT COMPOSITION OF EAGLES NEST AND ITS RELATIONSHIP TO OTHER ULTRAMAFIC ACHONDrites – D.A. Kring and W.V. Boynton, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721 USA.

Eagles Nest is an ultramafic achondrite consisting dominantly of equilibrated olivine (~81%) and smaller fractions of equilibrated high-Ca pyroxene (~6%), equilibrated Cr-spinel (<2%), phosphates (trace), Fe-sulfides and oxides (~7%), and deformed and/or altered materials (~5%). The olivine in Eagles Nest, like that in other ultramafic achondrites (Chassigny, Brachina, and ALH 84025 [1,2,3]), has a moderately high concentration of MnO, but at the same time has a high Fe/Mn ratio (50 to 70; Fig. 1). Although all four of these achondrites have similar olivine Fe/Mn, in the initial description of Eagles Nest [4] it was suggested that Eagles Nest is more closely related to ALH 84025 than to Brachina or Chassigny, because Eagles Nest and ALH 84025 both lack plagioclase and the minor element compositions of olivine (Cr and Ca), high-Ca pyroxene (Mn, Al, Ti, and Na), and Cr-spinel (Ti) in them are the same. In addition, because it had previously been proposed that ALH 84025 is a differentiated specimen from the same planetary body as Brachina [3], it was also tentatively suggested that Eagles Nest is similarly related to Brachina [4]. In this abstract we report the abundances of several critical trace elements in bulk samples of Eagles Nest and also conclude that Eagles Nest is probably related to ALH 84025 and Brachina.

The bulk Fe/Mn ratio in Eagles Nest is ~85 (Fig. 2), which is nearly identical to that in Brachina (~79) and ALH 84025 (~99), but much higher than that (~35 to 50) in Chassigny and related SNC meteorites. In the past, the Fe/Mn ratio has been used to identify samples that formed on different planetary bodies [e.g., 3,5]. Although this technique works well in basaltic systems, for cumulate rocks it may not be so useful because the distribution of Fe and Mn among different mineral phases, which may be fractionated from each other, can vary substantially (e.g., in Eagles Nest the Fe/Mn ratio in olivine is 50 to 70 while in high-Ca pyroxene it is 20 to 40). Despite this potential problem, however, the coincident absolute and relative abundances of Fe and Mn in bulk samples of Eagles Nest, ALH 84025, and Brachina, in addition to the coincident absolute and relative abundances of these elements in olivine, indicates it is more likely that Eagles Nest formed on the same or similar planetary body as Brachina and ALH 84025, rather than the SNC parent body.

The Al/Ga ratio in Eagles Nest is ~2500 (Fig. 3), which, although similar to that in Brachina (~1500), does not agree with that in ALH 84025 (~400). Like Fe/Mn, in the past the Al/Ga ratio has also been used to identify samples from different planetary bodies, but in this case we also suggest it may not be a good classification ratio. In basaltic rocks, Al and Ga are partitioned strongly into plagioclase, which presumably maintains a constant Al/Ga ratio. However, in plagioclase-free rocks, like Eagles Nest and ALH 84025, Al and Ga will be sited in phases in which the Al and Ga partition coefficients are often different. In the case of Eagles Nest and ALH 84025, some of the discrepancy may occur because of heterogeneous distribution of spinel, which is an Al-bearing phase.

The abundances of REE in Eagles Nest are enhanced relative to CI chondrites and the lighter REE are preferentially enriched (Fig. 4). This is an interesting result for a meteorite dominated by olivine, which, if evolving from a chondritic melt, should have subchondritic abundances and be LREE-depleted. This implies that either Eagles Nest is a
cumulate that was produced from an incompatible-element-enriched melt or that an incompatible-element-rich component was added late in the crystallization history of Eagles Nest. Chassigny has a similar REE signature and it and the nakhlites are believed to have been produced by melts with similar properties to those suggested by the REE in Eagles Nest [6]. Thus, although the bulk Fe/Mn ratio and petrologic properties of Eagles Nest suggest it may have come from the same or similar planetary body as ALH 84025 and Brachina, the REE indicate it was produced by igneous processes similar to those that occurred on the SNC parent body to produce Chassigny.

In conclusion, the composition of Eagles Nest, particularly its Fe/Mn ratio, supports (but does not prove) the relationship with ALH 84025 and Brachina which was proposed on the basis of their similar petrologic characteristics. It is possible that this relationship may be extended to LEW 88763 [7], which, like Brachina, is a granular rock consisting dominantly of olivine and lesser amounts pyroxene, plagioclase, and opaque minerals (including sulfides).