PRELIMINARY PALEOMAGNETIC ANALYSIS OF THE EAGLE STATION PALLASITE.

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Introduction: Remanent magnetizations recorded in minute FeNi inclusions in olivine from the Esquel, Imilac [1] and Springwater [2] meteorites record strong paleointensities that require the presence of an internally-generated dynamo in the main group pallasite parent body. The magnetizations are incompatible with a core-mantle boundary origin for these main group pallasites. Instead, injection of liquid FeNi metal from the core of an impactor into the shallow mantle of the main group pallasite parent body [1] can explain the magnetic data and available cooling rate constraints [3]. Here, we examine the Eagle Station (Figure 1) pallasite to learn whether its magnetic signature can similarly constrain the nature of its parent body.

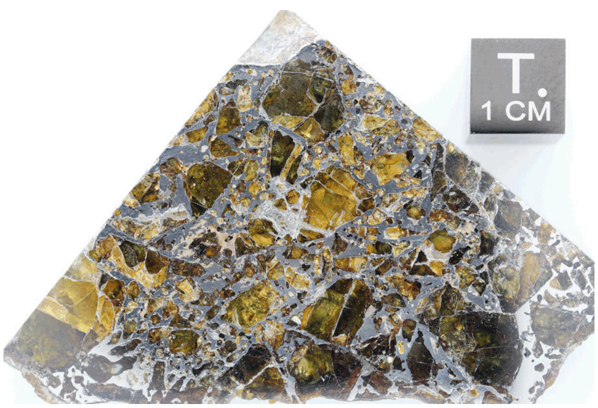

Figure 1. Eagle Station pallasite sample investigated.

Pallasites are meteorites with roughly equal amounts of FeNi metal and olivine crystals [4-5]. The main group pallasites have oxygen isotopic ratios that are well grouped near the terrestrial mass fractionation line, but the Eagle Station group and pyroxene pallasites have distinctly different isotopic compositions and are thus thought to have been derived from separate parent bodies (several in the case of the pyroxene pallasites). The oxygen isotope compositions of silicates of the Eagle Station group are similar to those in CV3 and CO3 chondrites [6]. The Eagle Station group is comprised of the Eagle Station, Itzawisis, Cold Bay and Karavannoe [7] meteorites. In general, olivine in the Eagle Station group has higher fayalite content (Fa_{19-20}) compared to the main group [5], and the metal is more Ir-rich [8]. Minor minerals in the Eagle Station group include diopside, chromite, stanfieldite, whitlockite, schreibersite, sphalerite, daubreelite and mackinawite [9]. Phosphates in the Eagle Station have low concentrations of rare earth elements [10]. Olivine in the Eagle Station pallasite is angular (versus rounded).

Methods: We report magnetic data from a sample of the Eagle Station pallasite obtained from the Vienna Natural History Museum (Figure 1). We use an approach for retrieving paleomagnetic data that uses single silicate crystals [11]. Such crystals can contain minute magnetic inclusions (in the single to pseudo-single domain range) that are magnetically stable on billion-year time scales [12-13]. These crystals are also less susceptible to alteration as compared to bulk pallasite samples containing massive FeNi metal [14-15]. As in our prior studies [1-2], we select only gem-like olivine samples for analyses that lack large inclusions (visible to the naked eye) that might be less magnetically stable (i.e., in the multidomain state) (Figure 2).

Figure 2. Example of subsample used for measurement of magnetic remanence.

We use a 3-component DC SQUID magnetometer, housed in the magnetically shielded room of the paleomagnetism laboratories of the University of Rochester, for remanence measurements. The magnetometer has a 6.3 mm access bore optimized for the measurement of single silicate crystals with low natural remanent magnetizations. For the measurement of magnetic hysteresis, we use the University of Rochester's Alternating Gradient Force Magnetometer and P1-probes.

Findings: Magnetic hysteresis data (Figure 3) indicate that olivine from the Eagle Station pallasite contains magnetic inclusions with single to pseudo-single domain inclusions (similar in magnetic domain state to gem-like olivine samples of main group pallasites [1]). Therefore, the Eagle Station olivines are suitable recorders of paleomagnetic fields.

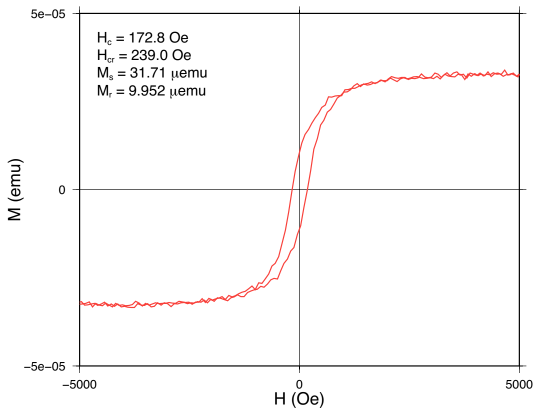

Figure 3. Magnetic hysteresis data on collected on gem-like olivine from the Eagle Station pallasite. Abbreviations: M_r: saturation remanence; M_s: Saturation magnetization; H_c, coercivity; H_{cr}, coercivity of remanence

Measurements of natural magnetic remanence were again restricted to subsamples of gem-like olivine (Figure 2). Measurements of 1-3 mm sized olivine yield natural remanent magnetizations values as high as ~9 x 10^{-8} emu (Table 1), well within the measurement resolution of the University of Rochester high sensitivity SQUID magnetometers.

Table 1: Natural Remanent Magnetizations (NRM) of gem-like olivine subsamples from the Eagle Station pallasite

Subsample	Weight (mg)	NRM (emu)
Crystal E X1	4.618	1.250e-08
Crystal E X2	2.826	1.130e-08
Crystal E X3	16.644	9.634e-09
Crystal E X4	11.566	2.333e-08
Crystal E X5	6.707	3.421e-08
Crystal G X1	5.013	1.871e-08
Crystal G X2	9.808	1.114e-08
Crystal G X3	18.381	3.176e-08
Crystal G X4	21.712	5.018e-08
Crystal G X5	9.049	9.461e-08

Discussion: Mn-Cr systematics measured on Eagle Station [16] suggest it, like the main group pallasites, formed very early in the solar system. If Eagle Station formed close to the core-mantle boundary of its parent body, we would not expect it to carry the record of a strong remanent magnetization because any internally-generated dynamo would have ceased by the time potential magnetic mineral inclusions in the olivine had cooled through their Curie temperatures. Magnetic measurements conducted to date suggest that gem-like olivine contains magnetic inclusions with the sizes (and associated domain states) capable of recording and preserving ancient magnetic fields should they have been present during cooling of the Eagle Station parent body. Whether the inclusions record such fields is testable through future Thellier-Coe paleointensity investigations, as conducted on the main group pallasites [1-2].

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