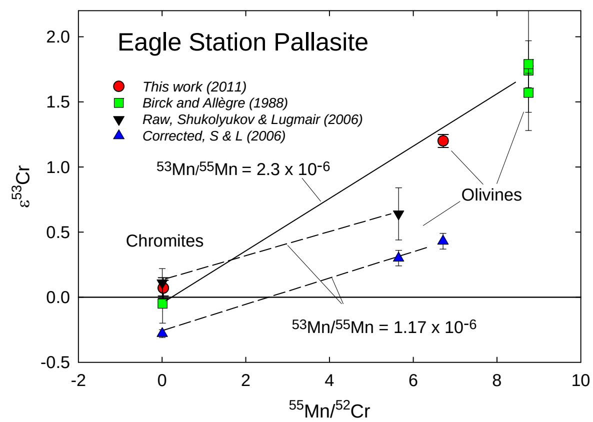
REVISITING Cr IN THE EAGLE STATION PALLASITE AND ITS SUGGESTED AFFINITIES TO CARBONACEOUS CHONDRITES. D. A. Papanastassiou[1,2] and J. H. Chen[1,3], [1]Jet Propulsion Laboratory, [2]Mail Code 183-335, [3]Mail Code 183-601, Caltech, 4800 Oak Grove Dr. Pasadena, CA 91109 (dimitri.a.papanastassiou@jpl.nasa.gov; james.h.chen@jpl.nasa.gov).

Introduction: Eagle Station (ES) belongs to an anomalous group of pallasites, based on chemical composition (high Ni, Ge, and Ir and siderophiles in the metal and high fayalite content of olivine [1]). The oxygen isotopic composition of this meteorite falls in the range found in whole-rock samples of CO3 and CV3 chondrites [2]. The first Mn-Cr measurements on ES by Birck and Allègre [3] determined a two point isochron for chromite and olivine grains with the slope defining the initial $^{53}Mn/^{55}Mn$ ratio of $(2.3\pm0.3) \times 10^{-6}$. In addition, these workers reported $\varepsilon^{54}Cr/^{52}Cr$ of 1.2 to 2.4 εu. Subsequent measurements by Shukolyukov and Lugmair [4] of the $^{53}Cr/^{52}Cr$ isotopic composition and the Mn/Cr ratios in ES chromite and olivine grains defined also a straight line, but with the slope corresponding to a significantly lower initial $^{53}Mn/^{55}Mn$ of $(1.17\pm0.09) \times 10^{-6}$ and an initial $^{53}Cr/^{52}Cr$ ratio of 0.11±0.11 εu for ES at the time of isotopic equilibration and closure. The $\varepsilon^{54}Cr$ values in both chromite and olivine from ES were reported as 0.71±0.2 εu. The similarities in $\varepsilon^{53}Cr$, $\varepsilon^{54}Cr$ and oxygen isotopes between ES and the Allende carbonaceous chondrite led them to confirm a genetic link between ES and a CV3-type precursor [4]. Based on the discrepancies between the initial $^{53}Mn/^{55}Mn$ ratios and the $\varepsilon^{54}Cr$ values [3, 4] and the importance of the proposed genetic link, we re-examined the Mn-Cr system in ES.

Results: To investigate this problem, we obtained a relatively fresh sample of ES for the Mn-Cr analyses, in connection with the investigations by B. Weiss [5]. The olivine fragments (received in a vial) were hand-picked to remove rusty, weathered material. The chromite-rich material was obtained by dissolving olivine with HF, the same procedure used previously [3,4]. The results are shown in Table 1 and Fig. 1. Our new ES data clearly plot closer to the isochron line reported by [3] rather than by [4]. Our data also yield an initial $\varepsilon^{53}Cr$ value of 0.07±0.08 and $\varepsilon^{54}Cr$ values of 0.22 ± 0.16 (chromite) and 1.9 ±0.15 (olivine). The data show distinct differences in the ^{54}Cr isotopic composition of chromite and olivine. This behavior is different than the results of [3] and [4], which show uniform $\varepsilon^{54}Cr$ between chromite and olivine (when the more precise data are used for [3]), but with differences in $\varepsilon^{54}Cr$ between [3] and [4] (see Fig. 2). For chromite our $\varepsilon^{54}Cr$ is closer to the values by [4]; for olivine our $\varepsilon^{54}Cr$ is closer those by [3]. The $\varepsilon^{54}Cr$ differences between our chromite and olivines are well defined.



Discussion: If we were to consider our ES $\varepsilon^{54}Cr$ values for chromite and olivine as evidence of isotopic heterogeneity for Cr, then it is possible that there is also isotopic heterogeneity in the initial $^{53}Cr/^{52}Cr$ and potentially the initial $^{53}Mn/^{55}Mn$, so the correlation lines in Fig. 1 may be mixing lines with little or no time significance. The distinct difference in $\varepsilon^{54}Cr$ for the ES chromite and olivine does not permit a unique $\varepsilon^{54}Cr$ in ES, for comparison with the $\varepsilon^{54}Cr$ values of carbonaceous meteorites, and a possible genetic link between the ES trio and carbonaceous chondrites [2]. In particular, since the Cr-rich phase (chromite) has normal $\varepsilon^{54}Cr$, it does not reflect the typically anomalous $\varepsilon^{54}Cr$ values in whole-rock carbonaceous chondrites. Chromium isotopes can be produced through spallation on target elements like Fe and Ni. Cosmogenic effects potentially could be large in meteoritic samples/minerals with high Fe/Cr ratios and long exposure histories. Early work on ES yielded relatively short cosmic-ray exposure ages of 47-51 Ma [6]. Recent measurements in metal separates of the pallasites yield up to about 1 Ga for Eagle Station [7]. However, based on the available abstract, it is not possible to assess the validity of such a long exposure age. For olivine, with high Fe/Cr and with ES having a cosmic ray exposure age of 1 Ga [7], it is possible that ^{53}Cr and ^{54}Cr are affected by cosmic ray spallation effects, on the target elements Fe and Ni. The isotope composition of spallation Cr in iron meteorites has been addressed extensively by Shima and Honda [8] and reexamined more recently [9]. We show, in Fig. 2, the correlation of $\varepsilon^{53}Cr$ and $\varepsilon^{54}Cr$ for Cr produced by spallation on FeNi. The correlation line is based on measurements on Carbo [9], reflects a slope of ~4 on this diagram, and is in agreement with [8]. The overall effects depend on effective Fe/Cr, shielding effects, and cosmic ray exposure age. For Fe/Cr ~500 in ES olivine, and based on the Carbo data (Carbo exposure age of 850 Ma) [9] we estimate that ε^{54}Cr effects in ES olivine could be at the (several) εu level. An order of magnitude lower exposure age would essentially eliminate this correction. We also note that the precise data for ES olivine follow distinctly below the spallation correlation line in Fig. 2. Hence, it is not clear that the ε^{54}Cr in olivine can be attributed to spallation effects. However, even if the ES olivine possesses an intrinsic ε^{54}Cr anomaly, the normal ε^{54}Cr in the chromite precludes any simple association of ES Cr isotope compositions with carbonaceous meteorite precursors, as suggested for oxygen [2] and by [4]. We do not have a simple explanation for the heterogeneous Cr isotopic composition between chromite and olivine in ES, especially since the chromite is obtained as inclusions in olivine. While it is possible that Cr from distinct sources contributed to ES, it is not clear how isotope heterogeneity can be preserved within a planetary differentiate. This implies that spallation effects for the Cr in olivine can not be excluded, after all.

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Table 1. Mn and Cr data in the pallasite Eagle Station

	Mn(ppm)	Cr(ppm)	^{55}Mn/^{52}Cr	ε^{53}Cr			ε^{54}Cr		
Sample									
Olivine	1222	217	6.715	1.2	±	0.05	1.9	±	0.15
Chromite a	8.65	358	0.029	0.07	±	0.08	0.39	±	0.19
Chromite b			0.029	0.07	±	0.06	0.22	±	0.16