PETROGRAPHY AND GEOCHEMISTRY OF HED METEORITE DHOFAR 2092. P. J. A. Hill[1]; G. R. Osinski[1,2]; N. R. Banerjee[1]; S. Nasir[3] [1]Department of Earth Science and Centre for Planetary Science and Exploration (CPSX), University of Western Ontario, London, ON, Canada. [2]Department of Physics and Astronomy, University of Western Ontario, London, ON, Canada, [3]Earth Sciences Research Center, Sultan Qaboos University, Muscat, Oman.

Introduction: Dhofar 2092 is a 440 g eucrite that was found within the Dhofar region (18°45.30'N; 54°31.15'E) of Oman in February 2015. Dho 2092 has a millimeter thick, dark brown fusion crust that lacks remaglypts. Instead the sample mainly has a rough surface with no clear evidence of contraction cracks present on this sample. The current face of the sample shows beige clasts that are surrounded by a light grey groundmass, as seen in Fig. 1.

Fig. 1: Photograph of Dhofar 2092 with cut face showing the beige clasts.

Petrography: Dhofar 2092 is polymict breccia containing ~50 vol% eucrite clasts. In transmitted light, the clasts are ophitic to subophitic with most ranging in diameter from 0.5 to 5 mm. The clasts are poorly sorted and are sub–rounded with one clast reaching up to 2 cm on the cut face. Clasts have been outlined in Fig. 2 to demonstrate the distinction between the groundmass and clasts.

Pyroxene (low and high Ca) and plagioclase make up most of the groundmass with pyroxene making up ~60 vol%, plagioclase ~35 vol%, and oxides & free silica making up 5 vol%. Most of the pyroxene is augite; however, low-Ca pyroxene (predominately pigeonite) is present as distinct exsolution lamellae. The groundmass has a distinct brown rusty colour in transmitted light that is generally absent within the clasts. The free silica that was observed occurred along grain boundaries within the fine-grained groundmass.

Ilmenite is also present within the sample. It occurs as two general textures: equant grains less than 100 µm in diameter and as a more irregular texture when associated with the free silica. Though no kamacite nor taenite was observed, troilite was found as euhedral grains <100 µm. Equant zircons with cross cutting fractures were identified; the fractures are likely a result of shock metamorphism. Alongside these fractures, some of the plagioclase within the clasts have undulose extinction. Irregular fractures were observed but not in high abundance. This sample has therefore been very weakly shocked. In terms of weathering products, the only alteration that could be identified was the rusty colour present in the groundmass suggesting this sample has been weakly altered.

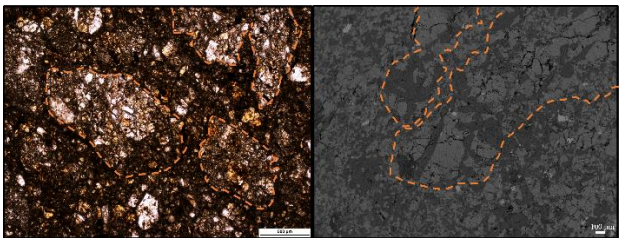

Fig. 2: A plain polarized light and backscattered electron image of Dhofar 2092 with clasts outlined in orange to demonstrate the textural difference between the clast and groundmass.

Isotope Geochemistry: The oxygen isotope composition of Dhofar 2092 is best represented by $\delta^{17}O$ = +1.7‰, $\delta^{18}O$ = +3.7‰, and $\Delta^{17}O$ = –0.255‰. The 4 runs used to determine the oxygen isotope composition of Dhofar 2092 are shown in Fig. 3. The calibration method used for triple oxygen isotope data gives an accuracy and precision better than ± 0.1‰ for both $\delta^{18}O$ and $\delta^{17}O$ [1]. This sample plots off the Terrestrial Fractionation Line (TFL) and is consistent with other HED meteorite falling within the Eucrite Fractionation Line (EFL) of $\Delta^{17}O$ = –0.241 ± 0.016‰ put forth by Greenwood et al. [2].

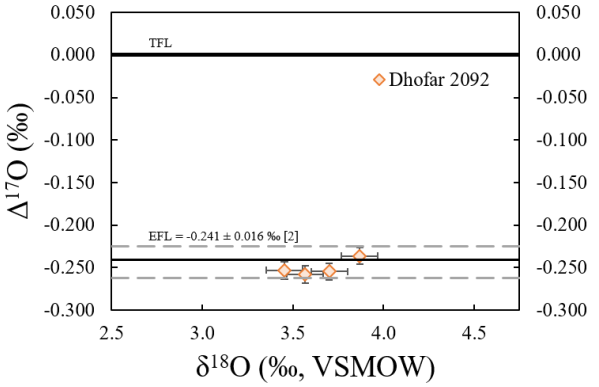

Fig. 3: $\Delta^{17}O$ (‰) vs. $\delta^{18}O$ (‰, VSMOW) runs of Dhofar 2092 plots with the EFL [4] and the TFL.

Bulk Chemistry: Major oxide geochemistry was determined using X-ray fluorescence (XRF) spectrometry at the Central Analytical and Applied Research Unit (CAARU) at the Sultan Qaboos University. The whole rock FeO–MnO content of Dhofar 2092 is consistent with that expected in HED meteorites (FeO/MnO = 37) [3]. The whole rock Mg# (0.42) and TiO_2 content (0.63 wt%) is consistent with polymict eucrites [4]. Finally, the CaO and MgO composition is also consistent with polymict eucrites (MgO: 7.68 wt%; CaO: 10.53 wt%) [5].

Mineral Chemistry: The plagioclase within the sample are comprised predominately of bytownite ranging in composition from An 86–93 (n=132; avg.±2σ =An 88±1.9). Fig. 4A shows a histogram of the distribution of the An content of plagioclase within Dhofar 2092. The augite observed in Dhofar 2092 ranges in composition from $En_{29}Fs_{24}Wo_{44}$ to $En_{34}Fs_{36}Wo_{33}$ (n=47; avg.±2σ=$En_{30\pm1.3}Fs_{27\pm4.2}Wo_{42\pm4.5}$). The orthopyroxene ranges in composition from $En_{35}Fs_{63}Wo_2$ to $En_{57}Fs_{41}Wo_9$ (n=127; avg.±2σ=$En_{37\pm6.2}Fs_{60\pm6.3}Wo_{3\pm2.8}$). As seen in Fig. 4B there are only 8 analyses that plot in the pigeonite compositional field. The free silica content ranged from 97.5 to 100.6 in SiO_2 (wt%). The only variation is observed in the FeO and Al_2O_3 (wt%) as seen in Fig. 4C.

Discussion: The mineral chemistry of Dhofar 2092 is consistent with that expected for HED meteorites. The pyroxene composition plots consistently with basalt material derived from Vesta [6], as seen in Fig. 4D, and the plagioclase composition is within the range observed in other eucrites [5]. The bulk major oxide chemistry of Dhofar 2092 indicates that is compositionally similar to polymict eucrites which is supported by the breccia texture observed in this meteorite.

References: [1] Ali A., Jabeen I., Gregory D., Verish R., Banerjee N. R. (2016) *Meteoritics & Planet. Sci., 51*, 981–995. [2] Greenwood R. C., Barrat J.–A., Yamaguchi A., Franchi I. A., Scott E. R. D., Bottke W. F., Gibhson J. M. (2014) *Earth Planet. Sci. Lett., 390*, 165–174 [3] Goodrich C. A. and Delaney J. S. (1999) *Geochem. Cosmochim. Acta, 64*, 149–160. [4] Grady M. M., Pratesi G. and Cecchi V. M. (2014) Atlas of Meteorites, *Cambridge University Press.* [5] Mittlefehldt D. W., Chou C.–L. and Wasson J. T. (1979) *Geochem. Cosmochim. Acta, 43*, 673–688. [6] Papike J. J. et al. (1998) *Amer. Mineral.*, 88:469–472.

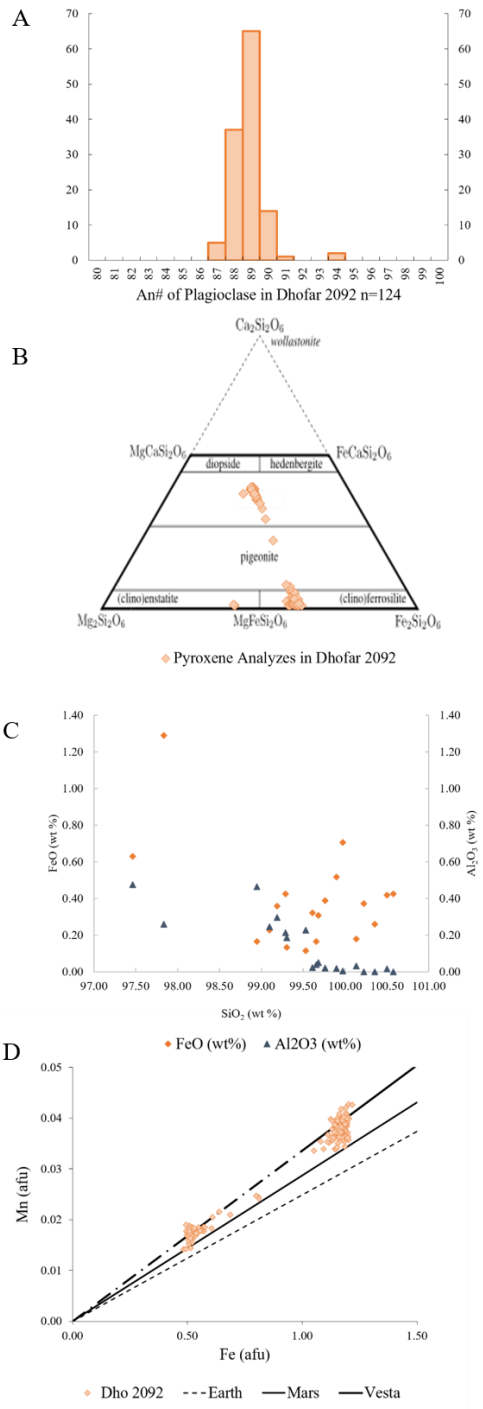

Fig. 4: (A) Histogram distribution of the An content in plagioclase within Dhofar 2092. (B) The composition of pyroxene found within Dhofar 2092 and their corresponding mineral phases. (C) Variation in FeO (wt%) and Al_2O_3 (wt%) against SiO_2 (wt%) of free silica in Dhofar 2092. (D) Mn (afu) vs. Fe (afu) for pyroxene grains found within Dhofar 2092. Lines for Earth, Mars and Vesta taken from [6].