COMPARISON BETWEEN ELEMENTAL RATIOS IN FUSION CRUSTS OF STANNERN EUCRITE, LUNAR METEORITE MAC 88105 & MARTIAN METEORITE NAKHLA; M. ZBIK & V.A. GOSTIN, Ian Wark Research Institute, University of South Australia, The Levels, S.A. 5095, and The University of Adelaide, Adelaide, South Australia 5005.

Impact phenomena result from the interaction of cosmic bodies that collide in space with ultra-high velocities. In small bodies, not protected by an atmospheric layer, impact phenomena are limited to interaction between solid components that shatter, melt and vaporise, spreading solid, liquid, and gaseous ejecta over the planetary surface and into space. The interaction between a meteoritic body and a large planet like Earth begins in the upper atmosphere. As the body penetrates to lower, and denser layers, lattice destruction increases and the surface layer of the meteor is heated up to many thousands of degrees, resulting in it being vaporised and melted. Under pressure from the oncoming air stream the molten matter on the surface of the meteoritic body is constantly blown off (ablated) and immediately quenched as the meteoritic body decelerates. Therefore the rapidly heated and quenched glassy fusion crust on the surface of meteorites, can be recognised as related to impact melts. Fragments of three meteorites were studied: Stannern eucrite, Lunar meteorite MAC 88105 and Martian meteorite Nakhla, all displayed significant fusion crusts. Polished thin and thick sections were made and were used for optical, scanning-electron microscope (SEM) and wavelength-dispersive electron microprobe studies. The chemical ratios of the outer layer of the fusion crusts for these different planetary meteorites were compared.

Mineralogy, petrology and geochemistry of the lunar meteorite MAC 88105. was described in [1] and recognised as a regolith breccia from the lunar highlands. Most common for this sample (MAC 88105.103) are meta-meltbreccias consisting of abundant anorthitic plagioclase clasts in a dense, fine-grained matrix. The Martian meteorite Nakhla was described in [2 & 3] as an olivine bearing pyroxenite consisting mostly of augite as the major mineral and less abundant Fe-rich olivine, plagioclase, K-feldspars, Fe-Ti oxides, FeS, pyrite, chalcopyrite, and a hydrated alteration phase that resembles iddingsite. The Stannern basaltic eucrite is a monomict breccia and was described in [4 & 5]. It consists of plagioclase, ortho and clinopyroxene, and also some tridymite, ilmenite, troilite, chromite and phosphates. The fusion crust of this eucrite was described in [6] as consisting of two distinct zones: outer ~ 200 μm which is bubbly, homogeneous and well-preserved quenched glass, and inner 100-150 μm, which has a dense massive texture without bubbles. The outer homogeneous zone is relatively well mixed while the inner zone is heterogeneous, which indicates rapid and therefore incomplete melting. Our results shown in Fig. 1a,b,c confirm a similar bi-modal structure in the lunar meteorite MAC 88105.130, and in the Martian meteorite Nakhla. Ca/Fe and Al/Fe ratios in the fusion crust are rather stable across the outer zone showing significant increase in reasonably volatile iron in comparison to refractory calcium in all studied meteorites. Iron was also more concentrated in comparison to aluminium in the aluminium rich Lunar MAC 88105.130 meteorite, while no significant changes were detected across the fusion crust of the Martian meteorite Nakhla, and an opposite trend has been obtained across the fusion crust of the Stannern Eucrite.

The parameter Mg/Mg+Fe, is highest for lunar fusion crust glass (Fig. 4), corresponds to the Lunar pyroxene and olivine, and confirms a low iron content in the lunar crust. However, perhaps due to iron concentration in the outer fusion crust layer, this parameter is almost half of its reported value from lunar impact glasses [7]. The highest value of Fe/Mn in this layer can be due to iron concentration. The intermediate value of Fe/Mn in the Martian meteorite, and the lowest value in the eucrite shows the opposite trend to the iron concentration in the parent bodies. The lowest Fe/Ti ratio in the lunar meteorite points to the high Ti content in lunar rocks. The aluminous nature of lunar highlands supports the highest Al/Mg+Si and smallest Ca/Al ratios, both related to the plagioclase content. Relatively high Ca/Mg+Si and highest Ca/Al ratios in the Nakhla meteorite could be due to the high Ca contents in Martian pyroxenes and olivines. Significant differences exist between fusion crust glasses and reported impact glasses within the lunar meteorite 88105 [7]. Because of this, the place of fusion crusts in studying the variety of impact glasses, is unclear, and requires further investigation. Knowledge about major ratio differences will also be useful for the identification of sources of cosmic dust spherules.

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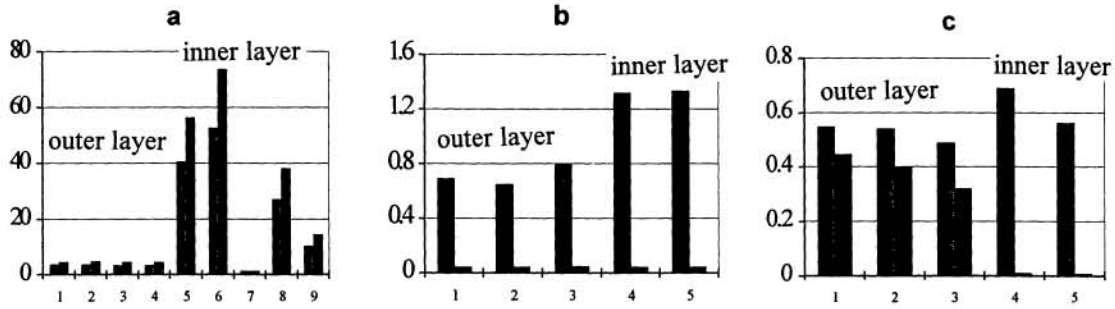

Fig.1 Ca/Fe & Al/Fe ratios respectively, across the fusion crust of a- Lunar meteorite MAC 88105, b- Martian meteorite Nakhla, c- Stannern eucrite.

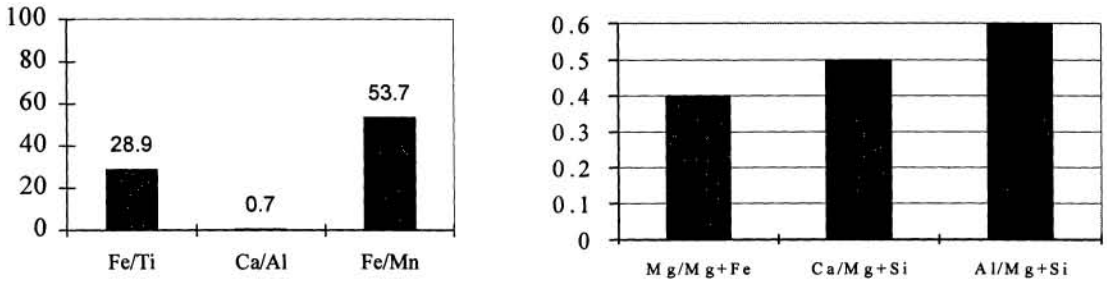

Fig. 2 Elemental ratios in Lunar meteorite MAC 88108.130 fusion crust outer, homogenous zone.

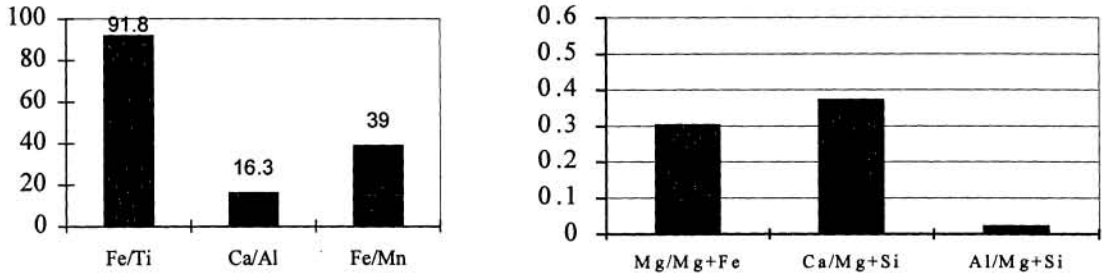

Fig. 3 Elemental ratios in Nakhla meteorite fusion crust outer, homogenous zone.

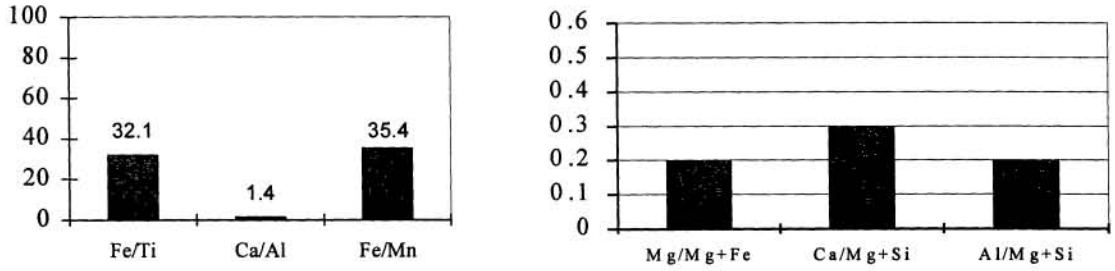

Fig. 4 Elemental ratios in Stannern eucrite fusion crust outer, homogenous zone.