I-TYPE COSMIC SPHERULES AS PROBES OF THE UPPER ATMOSPHERE.

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Introduction: I-type cosmic spherules are iron-rich micrometeorites (MMs) recovered from the Earth's surface that have experienced complete melting to form molten droplets [e.g. 1]. I-type spherules are dominated by magnetite (Fe_3O_4), wustite (FeO) and metal (FeNi) and are thought to form by the atmospheric entry heating, melting and oxidation of iron metal interplanetary dust. The Ni-bearing iron metal found within some spherules demonstrates their extraterrestrial origin. Although I-type spherules form only a small proportion of MMs (~2%) they are important since they are highly resistant to weathering and thus can provide information on the extraterrestrial dust flux over geological time.

The formation of I-type spherules by oxidation suggests that the oxygen abundance at the altitudes at which I-types decelerate will affect the final abundance of metal, wustite and magnetite. I-types thus provide a unique proxy to past atmospheric composition since other proxies, such as iron-sulphides within sedimentary rocks, record atmospheric oxygen abundance at the Earth's surface whilst I-types record this at altitudes above 50 km in the mesosphere.

Methods: A model based upon the entry heating simulations of Love and Brownlee (1991) was constructed that includes a treatment of oxidation in order to study the formation of I-types. The model specifically calculates the oxygen gained from oxidation and lost to evaporation and can predict the abundance of FeNi metal, wustite and magnetite in the resulting particle. The effect of atmospheric oxygen abundance relative to present atmospheric level (PAL) on mineralogy was investigated.

Results: Simulations indicate that oxidation increases modestly with entry angle, and significantly with particle size and in particular entry velocity. At 12 km/s particles larger than 100 μm in radius are largely magnetite, with metal only preserved in the smaller spherules. At 18 km/s particles more than 40 μm are mostly comprised entirely of magnetite. The smallest spherules are, in contrast, dominated by metal. Decreasing atmospheric oxygen content significant decreases the volume of oxide generated. At 0.1 PAL magnetite does not occur in spherules <100 μm in radius at 12 or 18 km/s, and all spherules are dominated by metal beads and a wustite mantle.

Discussion: Given estimates of surface atmospheric abundance prior to the great oxidation event of 10^{-5} PAL [3] this study indicates that Archean I-type spherules will comprise mainly of metal beads with a small development of wustite. Only if the oxygen content of the mesosphere is significantly higher than that of the troposphere and stratosphere would oxide-dominated I-type spherules be present in Archean sediments.

References: [1] Genge M. J. et al. 2008. *MAPS* 43:497-515. [2] Love S. & Brownlee D. E. 1991. *Icarus* 89:26-43. [3] England G. L et al. 2002. *Sedimentology* 49:1133-1156.