The use of micro-characterisation techniques to link the genesis of the Noril'sk giant Ni ore deposits and the Earth's largest mass extinction event

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The giant Ni-Cu-PGE orebodies of the Noril'sk-Talnakh camp in Arctic Siberia are some of the most valuable concentrations of metal on Earth. They are associated with the outpouring of over 3km^3 of mafic magma forming the 'Siberian Large Igneous Province' that erupted approximately 252 million years ago and have been linked to most calamitous mass extinction in Earth history, marking the boundary between the Permian and Triassic Periods (PT). Mass release of nickel into the atmosphere during ore formation has been postulated as one of the killing mechanism, by promoting the activity of the marine Archaea methanosarcina with catastrophic greenhouse climatic effects. But how could nickel, a non-volatile element, assumed to be largely sequestered at depth in dense magmatic sulfides, have been mobilised into magmatic gases and release into the atmosphere and oceans? Results of high resolution 2D and 3D micro-characterisation of globular ores from Noril'sk, such as micro-X-Ray Fluorescence mapping at the Australian Synchrotron and 3D micro-CT imaging, demonstrate the spatial association between sulphide blebs and former gas bubbles. 252 Ma ago, sulfide blebs would have managed to float their way up towards the top of the magmatic plumbing system. This 'bubble ridding' mechanism followed by degassing of the shallow, sulfide-saturated, and exceptionally volatile and Cl-rich lavas, would have permitted a massive release of Ni-rich volcanic gas and subsequent global dispersal of Ni as aerosol particles. Here, we provide evidence of physically attached nickel-rich sulphide droplets and former gas bubbles, frozen into the Noril'sk ores.