Geophysical Research Abstracts
Vol. 12, EGU2010-13916, 2010
EGU General Assembly 2010

Pipe formation and degassing from the Tunguska Basin in East Siberia and the consequences for the end-Permian environment

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The end of the Permian period is marked by a perturbation of the global carbon cycle and the largest known mass extinction on Earth. The crisis is commonly attributed to the formation of the Siberian Traps Large Igneous Province although the causal mechanisms remain disputed. We have recently suggested that heating of Tunguska Basin sediments by the ascending magma played a key role in triggering the crisis. Our conclusions are based on extensive field work in Siberia in 2004 and 2006. Here we present new data on contact metamorphism and gas release. Heating of organic-rich shale and petroleum bearing evaporites led to greenhouse gas and halocarbon generation in sufficient volumes to cause global warming and atmospheric ozone depletion. This is supported by experiments on heated rock samples from Siberia. The gases were released to the end-Permian atmosphere partly through spectacular phreatomagmatic pipe structures with kilometre-sized craters, formed during sill emplacement 252.0 ± 0.4 million years ago. We demonstrate that the composition of the heated sedimentary rocks below the flood basalts is the most important factor in controlling whether a Large Igneous Provinces causes an environmental crisis or not.