Geophysical Research Abstracts
Vol. 12, EGU2010-13788-3, 2010
EGU General Assembly 2010

Global Warming and Mass Extinctions Caused by Sediment Degassing of Volcanic Basins: Status Review

Sverre Planke (1,2) and Henrik Svensen (2)

(1) Volcanic Basin Petroleum Research, Oslo, Norway (planke@vbpr.no), (2) Physics of Geological Processes, University of Oslo, Norway

We have for the past decade worked on a hypothesis linking major environmental changes in Earth History to the eruption of Large Igneous Provinces (LIPs). It is well known that there are temporal correlations between LIPs and periods of global warming and/or mass extinctions. However, there are several problems explaining the environmental changes by extrusive volcanism. In particular, (1) there is no correlation between the size of a LIP and the environmental impact, (2) it is not possible to explain observed increases in isotopically light carbon by degassing of mafic magma, and (3) it is not sufficient carbon in mafic magma to explain the mass of atmospheric carbon needed to trigger global warming. Our hypothesis, initially published in 2004, stresses the emplacement environment. Sedimentary basins contain large volumes of volatiles or rocks that can be devolatized by heating. Magma intruding sedimentary basins will heat the host rock, causing massive degassing of the contact metamorphic aureoles. The type volatiles that are formed in the aureoles are strongly dependent on the host rock lithologies. Greenhouse gases, such as CH4 and CO2, are formed when organic-rich rocks or carbonates are heated, whereas poisonous gases (SO2, halocarbons, etc.) are formed when evaporate-rich sequences are heated. In contrast, only boiling (or formation of supercritical water) is taking place when barren sandstones or shales are heated. The sediment degassing hypothesis has been tested by focused studies of (1) the Paleocene-Eocene Thermal Maximum (PETM) and the Northeast Atlantic Igneous Province, (2) the Toarcian Oceanic Anoxic Event and the Karoo LIP, and (3) the end-Permian extinction and the Siberian Traps LIP. Borehole studies of aureole rocks in all three igneous provinces reveal a very high production potential of greenhouse gases. Heating experiments of petroleum-bearing evaporates from the Tunguska Basin in Siberia document that ozone-destroying halocarbons may have formed in large quantities during the end-Permian. Thousands of kilometer-sized vent complexes are further formed in all three provinces, documenting focused fluid flow from the aureoles to the atmosphere. The causal link between the intrusive volcanism and the environmental changes has further been strengthened by high-precision U/Pb dating of the sill complexes. The new dates show that the age of the intrusive event overlap with the age of the environmental changes. Published data and ongoing projects further show that intrusive volcanism may have played an important role during the end-Guadalupian (Emeishan volcanic province), the end-Triassic (Central Atlantic Magmatic Province), and the Cretaceous OAE1b (High Arctic LIP) events. There is, however, not presently any clear evidence for massive intrusive magmatism associated with the end-Cretaceous extinction (Deccan Traps and Chicxulub impact) or the two major Paleozoic extinctions. Currently, the main uncertainties of the sediment degassing hypothesis are related the understanding of the details of the rapid environmental changes and the volcanism, in particular: (1) absolute and relative timing of the intrusive events and the environmental changes (should be in the order of 10-100 kyr), (2) magma emplacement dynamics (one or more 10,000 km3 intrusive events may be sufficient to trigger global change), (3) gas production rates and eruption fluxes, and (4) climatic and environmental feed-back processes (ie., does sediment degassing cause or trigger environmental change). However, the geological record holds abundant information about both the environmental changes and the volcanic provinces, allowing better testing of the sediment degassing hypothesis in the years to come.