Project Report: The Siberian Traps and the end-Permian mass extinction

During the summer of 2008, I spent a month and a half in the field in Arctic Siberia. The eruption of the Siberian Traps ca. 252 million years ago was one of the greatest volcanic cataclysms in the geologic record, and may have been associated with the most severe biotic crisis since the Cambrian radiation. The remnants of this volcanism are exposed along the remote Kotuy River in Siberia (Figure 1).

The causes of the end-Permian mass extinction, during which > 90% of marine species vanished forever, remain poorly understood. The apparently coincident eruption of the Siberian Traps large igneous province—which is one of the most voluminous continental flood basalt provinces in Phanerozoic time—has been widely invoked as a potential trigger mechanism for the mass extinction (e.g. Campbell et al., 1992). By traveling to the scene of this ancient eruption in Siberia, I hoped to gather clues to the character and possible environmental consequences of the eruption. I accompanied a small team of scientists from Russia and MIT, including my doctoral advisor (Linda Elkins-Tanton).

The Siberian Traps are difficult to reach, and logistics were complex. As shown in Figure

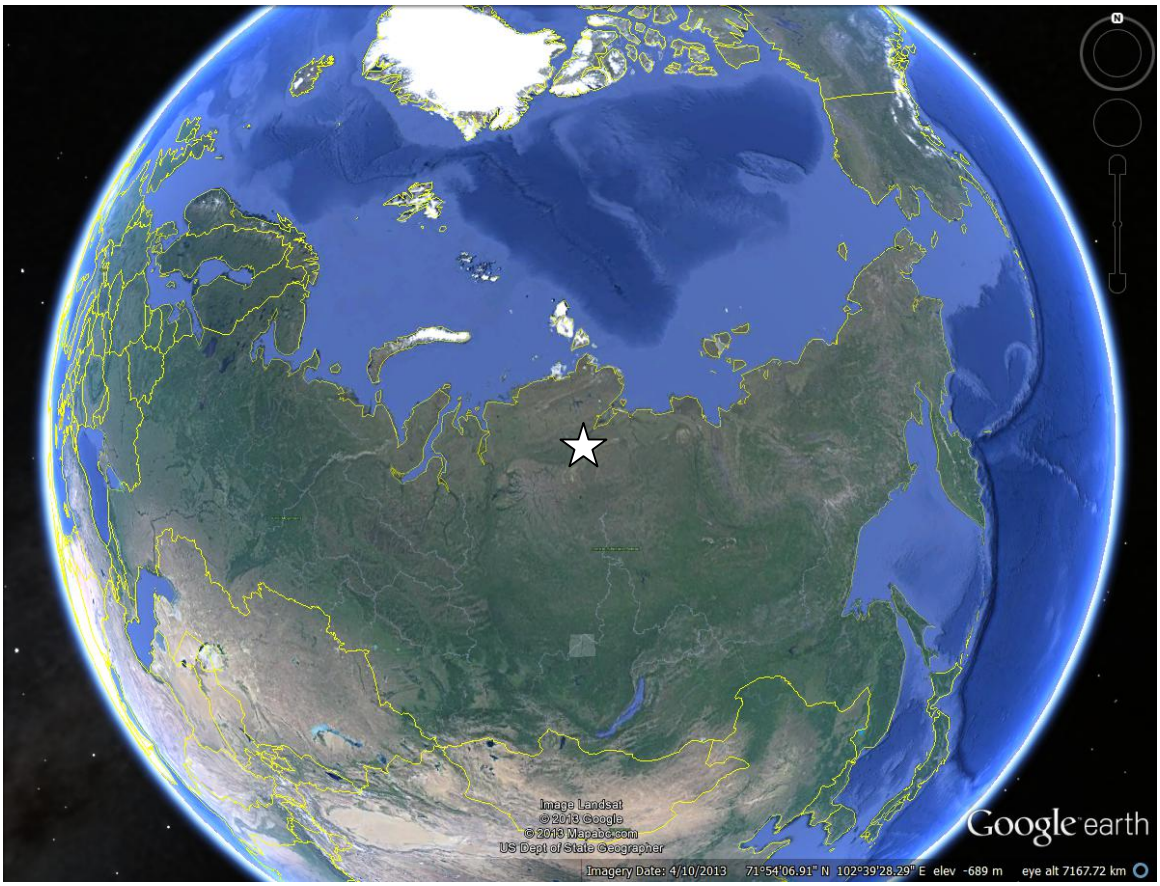

Figure 1. *White star marks the approximate location of field work in the summer of 2008, along the Kotuy River in Siberia (71°54 N, 102° 7' E).*

Figure 2. *We used small water craft to navigate the Kotuy River and reach the Siberian Traps volcanic stratigraphy. The cliffs shown here are limestones from the underlying sedimentary sequence.*

2, we traveled down the Kotuy River in small inflatable rafts (necessitating the purchase of waterproof gear). We collected samples from throughout the Permian-Triassic volcano-sedimentary sequence and brought these samples back to MIT.

I was able to extract small trapped inclusions from these samples that recorded the gas contents of the magma before eruption. I measured these gas concentrations in order to estimate the total release of toxic gases from the Siberian Traps eruption. Ultimately, I used these estimates of gas release as inputs to a global model of climate and chemistry. My climate simulations describe the global distribution and severity of the acid rain and ozone depletion that may have directly resulted from the eruption of the Siberian Traps, providing a potential link between the eruption and the decimation of biodiversity on land during the end-Permian.

The end-Permian world provides a sobering comparison to projections of climate change in the 21st Century. The results of our Siberian Traps research have important implications for the chemical and environmental factors that control the vulnerability, recovery, and diversification of life on Earth.

References

Campbell, I.H., Czamanske, G.K., Fedorenko, V.A., Hill, R.I., Stepanov, V., 1992. Synchronism of the Siberian Traps and the Permian-Triassic Boundary. Science 258, 1760-1763.