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The ignimbrite flare-up of the Sierra Madre Occidental, Mexico, and its relationship with the Eocene-Oligocene mass extinction

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“The Eocene-Oligocene transition was a critical period in Earth history, when the "greenhouse" climates of the Eocene were replaced by the "icehouse" conditions that persist today” (Prothero et al., 1999 GSA Penrose Conference Report). This global paleo-climate change coincided with a continued, long period (38-23 Ma) of large explosive eruptions that formed the Sierra Madre Occidental (SMO) volcanic province of Mexico, which is known as the largest rhyolitic ignimbrite province in the world. The SMO volcanic province extends continuously from the U.S.-Mexico border (31°N) to its intersection with the Mexican Volcanic Belt (21°N). A conservative estimate of the physical volume of the SMOVP rhyolitic ignimbrites is about 400,000 km3. This event is known as the “Ignimbrite flare-up” and occurred mainly from 38 to 23 Ma. It thus coincides with the Eocene-Oligocene global climate change. Caldera-forming eruptions are the most dramatic and destructive volcanic eruptions. A single classic caldera eruption (e.g., Yellowstone) could account for a complete devastation many kilometers around the caldera, and a major climate effect around the world by the large quantities of fine ash and volcanic gases emitted to the atmosphere. It has been estimated that 250 to 500 calderas with sizes similar to Yellowstone caldera are needed to account for the ignimbrites exposed in the SMO volcanic province. Recent studies indicate that many of these ignimbrites were derived from fissures related to regional

faults and graben forming elongated volcano-tectonic collapse structures (named as graben-calderas) rather than to classic semi-circular calderas. Amid this protracted voluminous activity, the Ethiopian-Yemeni (or Afro-Arabian) Traps produced extensive basaltic volcanism followed by massive rhyolitic ignimbrites between 31 and 27 Ma. The coincidence of two such prolific volcanic episodes likely was an important factor in causing the multiple global cooling events and associated faunal transitions that spanned the Eocene/Oligocene boundary. The protracted nature of the pyroclastic volcanism may explain why the extinctions and paleoclimate perturbations were apparently distributed over several million years.