

The link between Large Igneous Provinces (LIPs) and glaciations

RICHARD ERNST^{1,2}, NASRRDDINE YOUBI^{3,4}, ULF SÖDERLUND^{5,6}

¹Department of Earth Sciences, Carleton University, Ottawa, Canada; (Richard.Ernst@ErnstGeosciences.com)

²Faculty of Geology and Geography, Tomsk State University, Tomsk, Russia

³Department of Geology, Faculty of Sciences-Semlalia, Cadi Ayyad University, Marrakech, Morocco; (youbi@uca.ma)

⁴Instituto Dom Luiz, Universidade de Lisboa, Portugal

⁵Department of Geology, Lund University, Sölvegatan 12, Lund, Sweden; (ulf.soderlund@geol.lu.se)

⁶The Swedish Museum of Natural History, Stockholm, Sweden

Earth goes through periods of cooling that can include global, near global or regional glaciations which are observed in the Archean, Paleoproterozoic, Neoproterozoic, Ordovician, Permo-Carboniferous and Cenozoic times. One mechanism for cooling the climate relates to SO₂, which is a greenhouse gas and causes warming for days to weeks, but on a longer term, causes cooling because it forms sunlight blocking aerosols. The other key mechanism for global cooling is extensive weathering and associated CO₂ drawdown. Large Igneous Provinces (LIPs) can be linked to both mechanisms: massive release of SO₂ can occur during emplacement of some LIPs, and weathering of flood basalts is an efficient method for CO₂ drawdown.

The 725 Ma Franklin-Irkutsk LIP is linked with the start of the 715 Ma Sturtian glaciation and the ca. 580 Ma pulse of CIMP is associated with the Gaskiers glaciation. 2.5–2.45 Ga LIPs are associated with the Ramsey Lake-Makganyene glaciation. The Hirnantian glaciation (ca. 440 Ma) may be associated with poorly-dated ca. 440 Ma intraplate magmatism in several regions, including eastern Siberia, South Korea, Argentina and elsewhere. Permo-Carboniferous glaciations (P1-P4, 300 to 260 Ma) can be linked with widespread intraplate magmatism of the European North West African Magmatic Province (and its initiation as the 300 Ma Skagerrak LIP), and also the 260 Ma Emeishan LIP of China. In addition, there are examples of LIPs associated with the end of glaciations, such as a younger ca. 570 Ma CIMP pulse with the Gaskiers glaciation and the 2426 Ma Ongeluk LIP with the Ramsey Lake-Makganyene glaciation and ca. 2250–2240 Ma Hekpoort and 2215 Ungava-Nipissing LIPs with the Rietfontein glaciation, in these cases representing global warming events that helped end these glaciations.