# EVOLUTION OF THE CRETACEOUS SERRA GERAL GROUP AND ASSOCIATED SAND INJECTITES, SE SOUTH AMERICA

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ABSTRACT: The Serra Geral Group covers nearly one sixth of the Brazilian territory and parts of neighbouring countries (total = 917,000 $km^2$), attaining preserved thickness between 500-1000 m for 1,000 km between southwestern São Paulo and northern Rio Grande do Sul, maximum >1700 m in one drill core. The extreme variability of the volcanic province includes approximately 120 lava flows in each stratigraphic section from dominant basalt to subordinate rhyodacite and thousands of injected, silicified sand bodies with the shapes of dikes, sills, wings, laccoliths, extrudites and volcanoes. The volcanic rocks may be divided into six chemical types, but 16 are now recognized. Processes known from other continental flood basalt provinces formed dominant pahoehoe and aa basaltic lavas, but rhyodacites can be blocky although extensive sheets are common. One outstanding process occurred at high temperature as the thicker (>40 m) basalt flows cooled to 1,000 ºC. It seems that methane reached the flow as it ascended from the kerogen-rich sedimentary layers in the underburden, reacted with oxygen in minerals, raising the temperature to 1,600 ºC. The still-hot basalt remelted, so the newly-formed magma rised buoyantly and injected into the upper part of the solid core. This remelting fractionated metals, e.g., Cu, Au, Pt. This process explains the generation of the paralavas, previously incorrectly designated pegmatites. Overall, the volcanic group cooled to 150 ºC to be marked by another major geological process which was dominated by hot water and its vapor. Several unique characteristics of the Serra Geral Group among all intraplate basaltic provinces in the continents made the difference. The province has a major Guarani aquifer in the underburden made up of eolian sands. Also unique and essential was the arid climate during the entire magmatic effusion event. The horizontal position of the lavas durante hydrothermalism was also essential. As a result, the aquifer was heated to 150 ºC by the raised thermal flux from mantle melting and the entire Paraná Basin behaved as a steam engine. The engine altered and mineralized the lavas one by one, so each lava registers hydrothermal events H1, H2, H3. H1 sealed the most-recent flow, H2 injected explosively fluidized sand into the lava and H3 altered the basalt, caused ballooning and formation of amethyst geodes. Arid climate prevented the development of cooling fractures, which would have impeded the formation of geodes. Event H2 left an imprint of thousands of sand bodies in the volcanic group, and a remarkable set of hydrothermal volcanoes and craters in the three lowermost flows of the stratigraphy. Small sand volcanoes and sand sheets are also present. The site of the hydrothermal geode deposits is now marked at the surface as polygonal areas devoid of vegetation in the Atlantic Forest. The geode-endowed portions of the basalt have a lake or swamp at the surface. We thus call for a renewed investigation of the Serra Geral Group and sand injectites to fully understand the geological processes and find valuable ore and gem deposits.

KEYWORDS: SERRA GERAL GROUP, VOLCANISM, METALLOGENY, SAND INJECTITE.