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Volcanic-sedimentary features in the Serra Geral Fm., Paraná Basin, southern Brazil: Examples of dynamic lava-sediment interactions in an arid setting

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Abstract

The formation of volcanic–sedimentary interaction features in extreme arid environments is not a commonly described process. Specifically the occurrence of dynamically mixed sediments and juvenile igneous clasts as peperites, for water has been considered one major important factor in the processes of magma dismantling and mingling with unconsolidated sediment to form such deposits. The study area, located in south Brazil, shows a sequence of lava flows and intertrapic sandstone layers from the Paraná Basin, associated with the formation of clastic dykes, flow striations, peperite and 'peperite-like' breccias. Four processes are suggested for the genesis of the peperites: (a) fragmentation of the flow front and base; (b) sand injection; (c) dune collapse; (d) magma cascade downhill. The continued flow of a lava, while its outer crust is already cooling, causes it to break, especially in the front and base, fragments falling in the sand and getting mixed with it, generating the flow front 'peperite-like' breccia. The weight of the lava flow associated to shear stress at the base cause sand to be injected inwards the flow, forming injection clastic dykes in the cooled parts and injection peperite in the more plastic portions. The lava flow may partially erode the dune, causing the dune to collapse and forming the collapse 'peperite-like' breccia. The shear stress at the base of a flowing lava striates the unconsolidated sand, forming the flow striations. The sand that migrates over a cooled, jointed lava flow may get caught in the cavities and joints, forming the filling clastic dykes. These deposits are analogous to those found in the Etendeka, NW Namibia, and show that sediment–lava interactions in arid settings are widespread throughout the Paraná-Etendeka province during the onset of flood volcanism.
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Keywords: volcanic-sedimentary interaction; peperite; clastic dyke; flow striation; lava flow; aeolian sand

1. Introduction

The dynamic interaction between unconsolidated sediment and juvenile magma occurs in a number of volcano sedimentary sequences, and results in a mixed volcaniclastic rock known as 'peperite' (e.g. Skilling et al., 2002; and references therein). It is an important phenomenon as in many instances the sediment/lava interaction is fuelled by magma–water interactions, and may potentially lead to hydrovolcanic explosions (Skilling et al., 2002). Examples of sediment/lava interactions are also of interest as they often preserve vital information about the

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environment of deposition (e.g. Jerram et al., 2000), and the nature of the sediments during emplacement or intrusion of the magma.

In most sedimentary environments the unconsolidated sediment that the magma becomes in contact with will be saturated with water which will aid the development of the sediment/lava mingling due to hydraulic fracturing and gas expansion. However, the process of dynamic mingling in more arid environmental settings will be less influenced by the occurrence of water, and potentially will be more influenced by the mechanical efforts of the lava/magma emplacement, such as autobrecciation and traction in the base of the lava flow or in the walls of the intrusion, which become the most important mechanisms for the generation of the volcanic-sedimentary interactions. Very few examples of sediment lava interaction in arid settings have been reported (Jerram et al., 2000; Jerram and Stollhofen, 2002; Scherer, 2002). Jerram and Stollhofen (2002) presented detailed analysis of the dynamic interaction of aeolian sandstones with lava flows in the Etendeka, NW Namibia and showed the development of 'peperite-like' textures at some of the contacts. In the Paraná basin, a similar stratigraphy of aeolian sandstones interbedded with lava flows occurs (Scherer, 2002), but as yet a detailed investigation of the contact relationships and any dynamic sediment/lava mixing has not been presented.

In this contribution we present the results from a study case in an area located in south Brazil where the volcanic-sedimentary interactions are given by lava flows from the Cretaceous Paraná-Etendeka Province, over intertrapic lenses of aeolian sandstone, deposited in extreme arid conditions. We show that similar 'peperite-like' structures can be identified and a number of facies associations are defined, which help interpret the evolution of the onset of flood volcanism in this region. These findings are consistent with previous presented data from the equivalent stratigraphic markers in the Etendeka (Jerram and Stollhofen, 2002), allowing the further development of a facies framework for arid sediment/lava interactions, and identifying this as a process that was active over a large part of the Paraná-Etendeka province during the start of flood volcanism.

2. Regional geological setting

The volcanic rocks from the Paraná Basin, the Serra Geral Formation, along with its relatives in Namibia, make up the Paraná-Etendeka Igneous Province, one of the

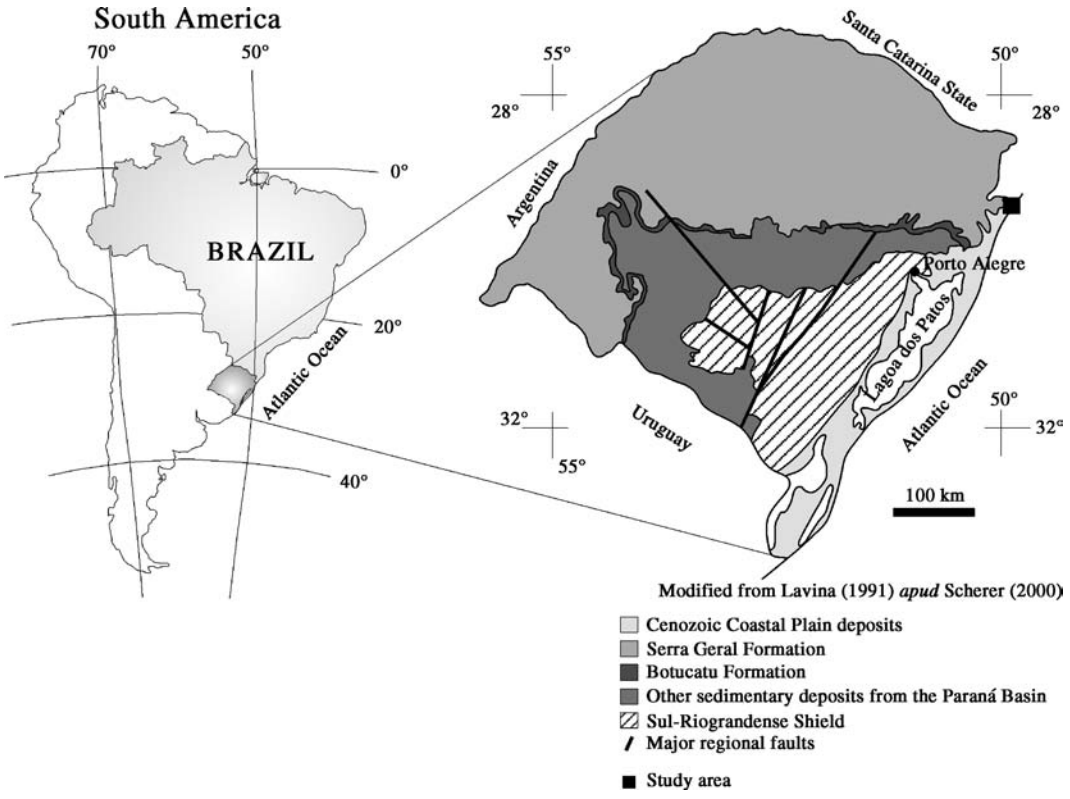

Fig. 1. Location map of the studied area in its regional geological context.

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