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Textural variations and fragmentation processes in peperite formed between felsic lava flow and wet substrate: An example from the Cretaceous Buan Volcanics, southwest Korea

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ABSTRACT

Multiple exposures of peperite within the Cretaceous Buan Volcanics, southwest Korea, have been examined in order to determine variations in their textural characteristics and to investigate their mode of formation. Along undulating boundaries between rhyolite (lava flow) and deformed host sediment expressed as a series of load and flame structures, exposures commonly contain two distinct types of peperite. Type-1 peperites are composed mostly of rounded juvenile clasts at their base and polyhedral juvenile clasts at their upper levels, interpreted to have formed via a two-stage process. Firstly, abrasion of juvenile clasts occurred after their fragmentation due to shear stress imparted by the overlying and still-moving lava flow, forming rounded juvenile clasts. Subsequent in situ quenching fragmentation of the lava flow produced clasts with platy to polyhedral shapes immediately after emplacement of the lava flow. Type-2 peperites laterally extend into the interior of featureless rhyolite as layers that decrease in thickness with increasing distance away from the flame zone. These layers exhibit horizontal textural variations, ranging from poorly sorted mixtures of ash- to block-sized angular juvenile clasts in the proximal zone, to closely packed polyhedral and tabular juvenile clasts with jigsaw-crack textures in the middle and distal zones. Type-2 peperite are inferred to have formed due to internal steam explosions that resulted from an expansion of heated pore water (leading to an increase in pore fluid pressure) that had been vertically injected into the interior of the rhyolite from the flame zone. The proximal zone, composed mainly of poorly sorted mixtures of juvenile clasts, represents the explosion sites. Juvenile clasts in the middle and distal zones are interpreted to have formed due to three separate processes: the development of fractures in the rhyolite during the internal steam explosions, injection of the host sediment through the fractures, and in situ quenching fragmentation. Deformation of the host sediment exerted an important control on peperite-forming processes, with the internal steam explosions suggested to have formed the closely packed, juvenile clasts with a jigsaw-crack texture rather than the clasts that are widely dispersed.

1. Introduction

Peperites are unique rock records of synsedimentary volcanism that form via dynamic interactions between hot magma (or lava) and unconsolidated to poorly consolidated, typically wet sediment (White et al., 2000; Skilling et al., 2002). A number of field-based investigations have been conducted for unraveling the processes of peperite formation in submarine (Brooks et al., 1982; Busby-Spera and White, 1987; Hanson and Wilson, 1993; McPhie, 1993; Goto and McPhie, 1996; Hanson and Hargrove, 1999; Hunns and McPhie, 1999; Doyle, 2000; Squire and McPhie, 2002), fluvial (Hole et al., 2013), lacustrine (Cas et al., 2001; Erkül et al., 2006; Tucker and Scott, 2009), and aeolian environments (Jerram and Stollhofen, 2002; Petry et al., 2007; Waichel et al., 2008). These works have improved general understanding of the factors controlling fragmentation processes, such as the physical behavior of the magma or lava, which depends largely on its composition (Dadd and Van Wagoner, 2002), grain size and fluid content of the host sediment (Busby-Spera and White, 1987; Squire and McPhie, 2002), emplacement conditions (e.g., confining pressure; Kokelaar, 1986), and the tempo-spatial variations of these factors (Goto and McPhie, 1996). Most examples formed from interactions between lava/magma of mafic to intermediate composition and wet host sediment; examples derived from felsic lava having flowed onto a wet substrate are rare (Tuffen et al., 2001; Branney et al., 2008; McLean et al., 2016).

In the western part of the Buan Volcanics, southwest Korea, a laterally continuous exposure of peperites <150 m in length occurs at the base of a rhyolite lava flow (the Gomso Rhyolite; Koh et al., 2013) that conformably overlies lacustrine sediment of the Gyeokpori Formation (Kim et al., 2003). This pairing provides a valuable opportunity to study peperite-forming processes related to interactions between a

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felsic lava flow and a wet host sediment. The peperites are composed of angular and rounded juvenile clasts, and exhibit lateral and vertical variations in thickness, shape, size, and packing degree of the juvenile clasts, implying that different fragmentation processes occurred at different locations along the lava flow's base. In this paper, we document the morphological characteristics of the peperites with the textural variations and interpret the fragmentation mechanisms responsible for their formation.

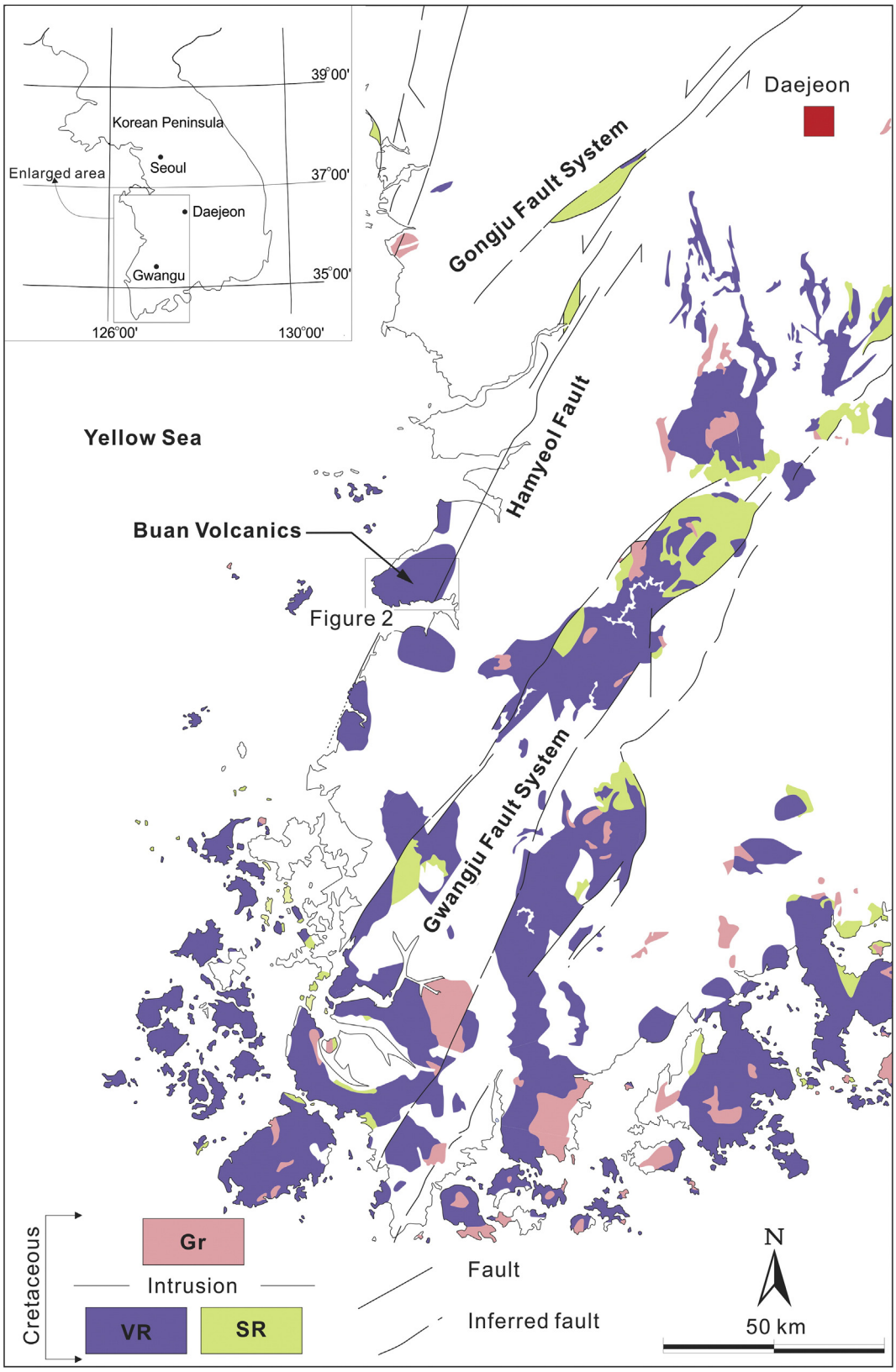

Fig. 1. Distribution map of Cretaceous granite and volcano-sedimentary successions along the Gongju, Gwangju, and Hamyeol NE–SW trending strike-slip fault systems, southwest Korea (Modified from Ko et al. (2015)) (Abbreviations: VR = Volcaniclastic Rocks, SR = Sedimentary Rocks, Gr = Granite).

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