with only a few sills identified. By contrast, the Niri Mbwelesu crater/conduit wall exposes complex shallow level dyke and sill complexes that have been disrupted by subsequent explosive eruptions (Fig. 2c). The large number of accidental volcanic lithic clasts (pieces of sills and dykes) are present on the surrounding volcanic flanks and also result from these periodic explosions. The sills are interconnected through oblique dykes with irregular, chilled margins, and occasional peperitic contact zones, especially when in contact with fine ash and lapilli successions (Fig. 2c). The major sill exposed at Niri Mbwelesu is dish-like in cross section and about 20 m thick (Fig. 2c). Thinner interconnected intrusions also form u-shaped cross sections suggesting some sort of ponding during emplacement into the unconsolidated, commonly fine grained tephra (Fig. 2c). Similarly, a few individual u-shaped thin (m-scale) sills are exposed in the inner crater wall independently of the major sill and dyke complex (Fig. 2d).

Conclusion

The presence of large interconnected sill and dyke complexes as well as very shallow lava ponds associated with pyroclastic (spatter and socora) cones suggest that shallow intrusive processes play an important role during the eruptions of frequently active mafic volcanic centers. Moreover, the presence of such shallow sills and dykes pose significant hazard during the construction of a pyroclastic cone. The large ponded, "hidden" melt pockets in the continuously growing pyroclastic edifice are able to break through the pyroclastic wall and initiate unexpected lava flows or collapses of the cones. Also the large ponded magmatic bodies can retain heat long time, and provide preferential "pre-heated" pathways for new, fresh melt to reach the surface. Because the cross sections were generated by explosive disruption of the pyroclastic edifice, we also suggests that such exposures could expose solidified intrusive bodies that may have originated from other neighboring vents.

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References

McCall GJH, LeMaitre RW, Malahoff A, Robinson GP, Stephenson PJ (1969) The geology and geophysics of the Ambrym Caldera. New Hebrides, symposium volcanoes and their roots. Oxford, England, pp 682–696

Robin C et al (1993) Giant tuff cone and 12-km-wide associated caldera at Ambrym Volcano (Vanuatu, New-Hebrides-Arc). J Volcanol Geother Res 55(3–4):225–238

Peperites and soft sediment deformation textures of a shallow subaqueous Miocene rhyolitic cryptodome and dyke complex, Pálháza, Hungary

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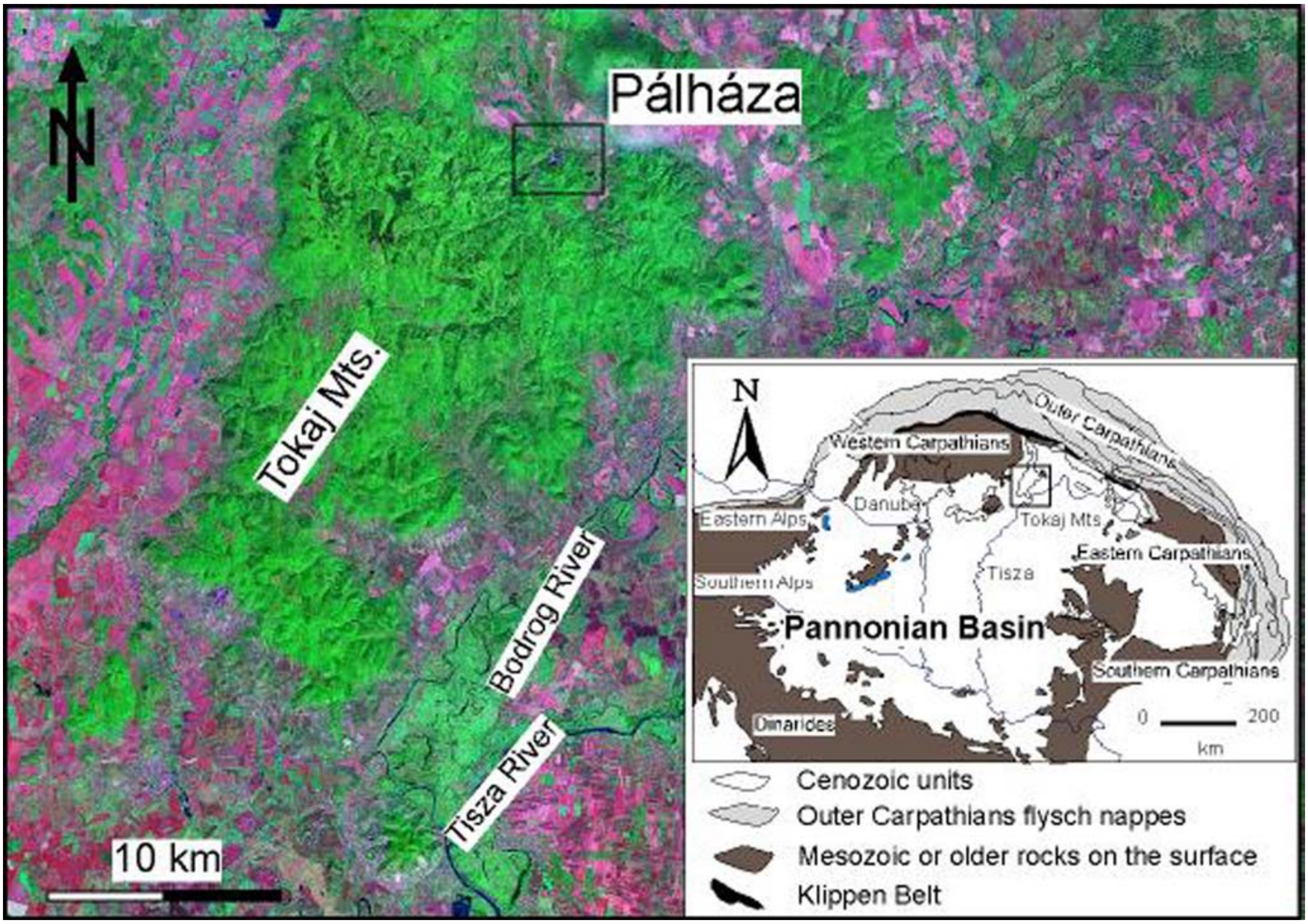

Fig. 1 Overview map of the Carpathian–Pannonian geological environment and the Tokaj Mountains in MrSID satellite image

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Miocene rhyolitic shallow intrusions, cryptodomes and domes emplaced into soft, wet sediment in a shallow subaqueous environment form a large intrusive complex in the NE side of the Tokaj Mountains at Pálháza in NE-Hungary. The intrusive complex show two types of interaction textures with the host sediment: (1) blocky peperites formed on dm-scale, and (2) irregular contacts closely resembling globular mega-peperites on the scale of tens of meters. The > 200 m thick succession of intrusive complexes are interpreted to be a shallow dyke, cryptodome, and dome complex formed from generally steady growth within a shallow subaqueous environment, similar to those reported from Ponza, Italy.

Keywords: Cryptodome · Peperite · Phreatomagmatic · Hyaloclastite · Obsidian · Perlite

Introduction

Miocene calk-alkaline andesitic, rhyo-dacitic and rhyolitic volcanic rocks form an erosional remnant of a complex sub-aqueous to subaerial volcanic complex in the central part of the Carpathian volcanic arc, called the Tokaj Mountains (Fig. 1). Volcanic activity in the Tokaj Mountains took place in the Miocene between 15.2 and 9.4 Ma, based on K/Ar age determination (Pécskay et al. 1989, 1995). Rhyolitic rocks of the Tokaj Mountains consist of coherent lava/intrusion bodies as well as pyroclastic successions and their reworked counterparts. Pálháza is located in the NE of the Tokaj Mountains and it is a complex subvolcanic body of rhyolite cryptodomes, domes, and intrusions many of them with perlitic texture (Perlaki and Szoor 1973) (Fig. 2a). The studied rhyolitic coherent lava dome and cryptodome succession is intruded into Miocene marine fine grained siliciclastic sediments.

Peperitic contact zones of dykes, sills, cryptodomes, and domes

Peperite is used as a genetic term applied to a rock formed essentially in situ by disintegration of magma intruding and mingling with unconsolidated or poorly consolidated, typically wet sediments (White et al. 2000; Skilling et al. 2002). In general these are small volume mafic volcanic rocks especially in association with phreatomagmatic eruptions and are preserved in diatremes that are commonly intruded by dykes and sills (Lorenz et al. 2002; Martin and Németh 2004). In such settings, peperite commonly forms upon disintegration of the magma and mixing with the host pyroclastic debris. In slightly larger volume eruptions from acidic magmas, especially in subaqueous conditions, it is possible that a group of nested cryptodomes and domes could develop structures and textures very similar to mafic dyke and sill complexes, albeit under different geometrical scales and configurations.

A large quarry in the NE side of the Tokaj Mountains exposes a 3D view of an at least 200 m thick succession of complex rhyolitic cryptodomes, partly intruded into wet, unconsolidated marine sediments (Fig. 2a, b). The individual cryptodomes are

Fig. 2 **a** Overview of the Pálháza quarry. Coherent magmatic bodies (cb) intrude marine sediments (s). Along the contacts, thick peperitic margins are present (p). In the upper level of the quarry, hyaloclastite units flank (hy) the dome complexes. **b** Close-up view of the contact between a dome (cb) and marine sediments (sds). Wide zone of jig-saw fit peperite (jf), and clast-rotated peperitic margin (crm) separates the coherent magmatic body and the host sediment. **c** Lensoidal-shaped coherent body (cb) in the deepest level of the quarry forming a peperitic contact (p) with the host sediment (s). **d** Lensoid shape columnar jointed, moderately perlitic rhyolitic intrusion in the upper level of the quarry. *Outlines* represent sediment dykes intruding into the peperitic zone of the complex

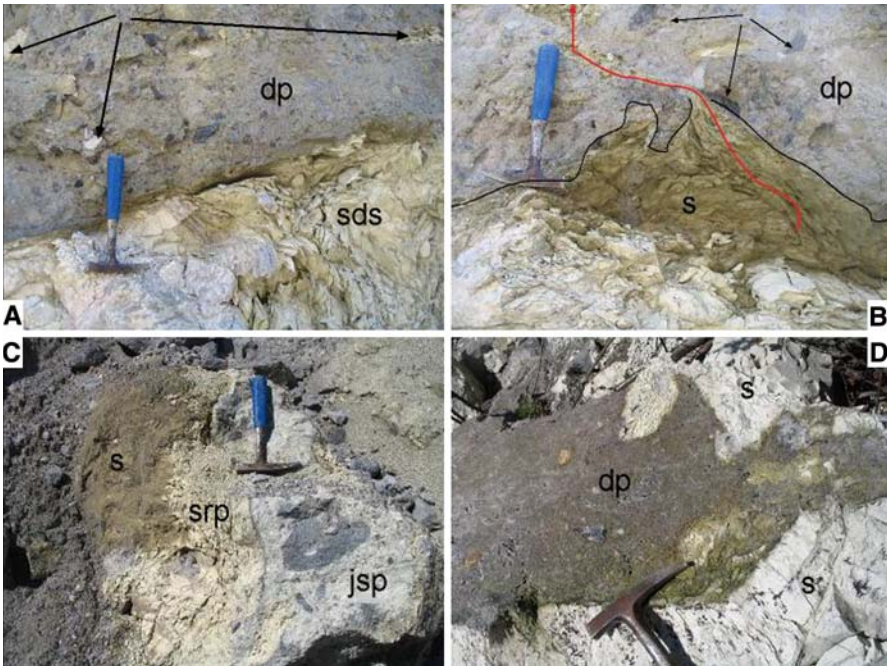

Fig. 3 **a** dm-scale features of the peperitic contact. Dispersed peperite (dp) contacted to the host sediment (sds). *Arrows* point to the angular shape coherent rhyolitic clasts. **b** Irregular margin between host sediment (s) and dispersed peperitic (dp) zone. *Red arrow* represents the sedimentary dyke intruding deeply into the dispersed peperitic zone. **c** Transitional zone between host sediment (s) sediment-rich peperitic zone (srp) and jig-saw fit peperitic zone in a dm-scale geometry. **d** Complex texture of the contact zone of dispersed peperitic zone (dp) and host sediment (s) in dm-scale geometry

radially jointed and in cross sectional view are lensoid in shape (Fig. 2c, d). Many of the margins of the rhyolitic cryptodomes have strongly perlitic texture. Each $<$ 50 m long and 15 m thick coherent rhyolite dome is surrounded by few meters of breccia (Figs. 2b, 3a). These breccia zones consist of angular rhyolitic fragments (Fig. 3a, b), many with jig-saw fit near the coherent body (Fig. 3c). Further away from the coherent body, the texture of the breccia becomes more matrix supported, with only isolated domains of jig-saw fit clasts (Fig. 3a). With further distance from the coherent rhyolitic bodies in the basal level of the exposed quarry sections, the proportion of marine sediments in the breccia increases dramatically (Fig. 2b).

In addition, up to 0.5 m wide, but undulating thickness of muddy sedimentary dykes penetrate deep into the jig-saw fit breccia zones surrounding the coherent lava bodies (Fig. 2d). These homogenized mudstone dykes commonly form sheared dissected fragments that are connected to each other by zones that are only a few centimeter thick (Fig. 3b). In the muddy clastic dykes strongly perlite-textured angular fragments of rhyolitic clasts (millimeter to centimeter diameter) form small groups that are randomly distributed through the body. A gradual transition from jig-saw peperite through clast-rotated peperite is observed with increasing distance from the coherent body (Fig. 3c). An undulating dm-thick zone of homogenized, often plastically deformed mud with few angular rhyolite clasts forms the most sediment-rich zone of the peperitic contacts (Fig. 3d).

Conclusion

The identification of a peperitic margin along the Pálháza rhyolite complex attest its predominantly shallow subsurface intrusive origin, where rhyolitic magma intruded unconsolidated and wet fine grained sediments. The identification of blocky versus globular peperite textures seemingly depends on the geometrical scale of the intrusive/sediment contact. The textures observed are similar to those that have been reported from peperites associated with mafic phreatomagmatic volcanoes (Martin and Németh 2005).

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References

Lorenz V, Zimanowski B, Buettner R (2002) On the formation of deep-seated subterranean peperite-like magma-sediment mixtures. J Volcanol Geother Res 114(1–2):107–118

Martin U, Németh K (2004) Mio/Pliocene phreatomagmatic volcanism in the western Pannonian Basin. Geological Institute of Hungary, Budapest, pp 1–193

Martin U, Németh K (2005) Blocky versus fluidal peperite textures developed in crater lakes and vent fills of phreatomagmatic volcanoes in Mio/Pliocene volcanic fields of Western Hungary. J Volcanol Geother Res (in press)

Pécskay Z, Balogh K, Széky-Fux V, Gyarmati P (1989) Geochronological investigations on the Neogene volcanism of the Tokaj Mountains. Can J Soil Sci 69(2):635–655

Pécskay Z, Lexa J, Szakács A, Balogh K, Seghedi I, Konecny V, Kovács M, Márton E, Kaliciak M, Széky-Fux V, Póka T, Gyarmati P, Edelstein O, Rosu E, Zec B (1995) Space and time distribution of Neogene-Quaternary volcanism in the Carpatho-Pannonian region. Acta Vulcanologica 7(2):15–28

Perlaki EI, Szoor G (1973) The perlites of the Tokaj Mountains. Acta Geologica Academiae Scientiarum Hungaricae = Magyar Tudományos Akadémia Földtani Közlönye 17(1–3):85–106

Rózsa P, Papp L (1988) Tokajii-hegysegi vulkani es szubvulkani kizetek elkulonitese szemnagysagi osszeteteluk alapjan. [Volcanic and subvolcanic rocks from the Tokaj Mountains, northeastern Hungary; grain size distribution]. Földtani Közlöny 118(3):265–275

Skilling IP, White JDL, McPhie J (2002) Peperite: a review of magma-sediment mingling. J Volcanol Geother Res 114(1–2):1–17

White JDL, McPhie J, Skilling I (2000) Peperite: a useful genetic term. Bull Volcanol 62(1):65–66

Relationship of low-field AMS fabrics with magma flow in Permo-Carboniferous dolerite dykes of southern Sweden

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