DEPOSITIONAL RECORD OF A PLIOCENE NESTED MULTIVENT MAAR COMPLEX AT FEKETE HEGY, PANNONIAN BASIN, WESTERN HUNGARY

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Abstract: The Mio/Pliocene Bakony-Balaton Highland Volcanic Field includes more than 100 alkaline basaltic volcanoes. The maar complex Fekete-hegy is volumetrically one of the largest volcanic complexes of the BBHVF. Fekete-hegy forms a lava-capped butte in the central part of the volcanic field with basaltic lava flows overlying pyroclastic units. At least 3 vents have been identified at Fekete-hegy. Every single vent started initially with phreatomagmatic activity, interpreted on the basis of the presence of chilled, angular, blocky, slightly to moderately vesicular sideromelane glass shards, accidental lithic clasts and bedding characteristics of the pyroclastic units. Fekete-hegy is considered to be a large nested phreatomagmatic volcanic vent system,

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Introduction

The Bakony- Balaton Volcanic Field (BBHVF) is located in the western part of the Pannonian Basin, Hungary (Fig. 1). The Pannonian Basin is considered to be a back-arc basin with a subduction-related Neogene calk-alkaline volcanic chain at its northern to eastern margin (Szabó et al. 1992). During the Miocene, extensional tectonic events behind the subduction zone resulted in lithospheric thinning and asthenospheric uprise (Stegena et al. 1975; Horváth 1993). From Late Miocene to Pleistocene, alkaline basaltic volcanism characterised this region (Szabó et al. 1992). The BBHVF consists of eroded remnants of scoria cones, tuff rings, and maars (Jugovics 1968, 1969; Jámbor et al. 1981; Németh & Martin 1999a, b). In this paper we show an example from a nested phreatomagmatic vent system, Fekete-hegy, and its characteristics.

Nested phreatomagmatic vent system, Fekete-hegy

Different pyroclastic rock crops out at Fekete-hegy may represent more distal or proximal sites in relationship to their volcanic source according to the erosional stage of the volcanic butte. On the basal pyroclastic units, large bombs of basaltic rocks, peridotite lherzolite nodules (< 70 cm) or blocks from the basement (< 40 cm) as well as large (dm-scale) flattened and softly deformed unconsolidated sediment rags occur often in only crudely stratificated or massive beds, that represent a near vent facies. There are coarse-grained lapilli tuff beds that contain fragments of purely preserved tree trunks (cm-scale) indicating a forested area surrounded the vents. Other pyroclastic deposits are very thinly and low-angle (< 10°) cross-bedded with abundant dune structures with low amplitude (cm-scale) and long wave length (m-scale). Varying content (~ 25 – 90 vol%) of accidental lithic clasts types as well as different kinds of pyroclastic deposits in respect of bedding characteristics, grain size or juvenile to accidental clast ration (depending on more or less intensive fragmentation, water content, depositional mechanism and other primary factors of the system) show a complex eruptive history in an area of ~ 15 km^2. The pyroclastic successions locally may even be formed by simultaneous activity of two (or more) closely spaced (100 ms-scale) vents inferred from several indicators such as 1) field relationships of different pyroclastic units, 2) areal distribution of key beds or 3) grain size distribution of pyroclastic beds and their largest accidental lithic clast type and size parameters, similarly to method have been applied succesfully from the Eifel volcanic field, Germany (Bogaard & Schmincke 1984) .

The basal pyroclastic deposits of the nested maar system of Fekete-hegy were formed by pyroclastic density currents (base surges), fall out- and volcaniclastic mass flows generated by syn-volcanic reworking interpreted on the basis of their grain-size, bedding characteristics, volcanic textures and km-scale field relationships (Druitt 1998; White & Schmincke 1999; Dellino & La Volpe 2000). The presence of a large amount (up to 90 vol%) of accidental lithic fragments (Lorenz 1986; Gevrek & Kazanci 2000) in the pyroclastic rocks of Fekete-hegy derived from the immediate underlying fluvio-lacustrine, Late Miocene (Pannonian) sedimentary units indicate that the interaction of the ascending magma with water occurred in water saturated Late Miocene shallow marine to fluvio-lacustrine siliciclastic sediments as well as with water in aquifers which have been part of a wide-spread and multilevel karst system in Mesozoic carbonate rocks similarly to the other well-characterized nested maar system at BBHVF, called the Tihany Maar Volcanic Complex (Németh et al. 2001).

The final phase of the activity in the maar/tuff ring complex at Fekete-hegy is represented by effusive eruptions of lava flows and lava lakes which are filling and covering the pyroclastic deposits in an area of at least 10 km^2 (Figs 1 and 2). The changing in the eruptive style presumably is caused by the termination of water supply in the basement (Houghton & Schmincke 1989; White 1991). The latest pyroclastic deposits are red, dark brown scoria agglomerate and tuff breccia interpreted on the basis of field relationships, bedding characteristics and scoria clast flattening to be formed by at least two scoria cones (Figs 1 and 2). Both scoria cones also started with a short period of phreatomagmatic activity indicated by the presence of thin veneer of accidental lithic clast-rich basal units corresponding to the overlying scoriaceous volcanic piles. They are generated by a Strombolian-type explosive activity followed by the eruption of small volume lava flows. Lava fountaining is inferred to be an important stage of the eruptive history of these scoria cones, based on the presence of clastogenic lava flows and welded agglutinate beds (Wolff & Sumner 2000) in several locations in the western escarpment of the butte.

Conclusion

Fekete-hegy is interpreted to be an erosional remnant of a closely spaced phreatomagmatic vent system, and predates the volcanoes developed west of this system. The more-less NS trending chain of identified volcanic edifices suggests that the Fekete-hegy maar complex either developed in NS valley system and/or is associated with pre-existing structural elements with the same orientation. The development of such a long (10 km-scale) phreatomagmatic vent chain in the geometrical centre of the BBHVF has a significance. Its existence implies three important conclusions on the basis of this study; 1) long structural elements and/or valley systems during the initiation of the eruption of the Fekete-hegy volcanic complex must have been existed, 2) this valley system were well-drained and provided substantial water sources to sustain phreatomagmatic volcanism producing a large volume of phreatomagmatic tephra and 3) that in the final stage of the eruption of the Fekete-hegy vent system pure magmatic fragmentation of the alkali basaltic magma produced Strombolian-type explosive eruptions building up at least two scoria cones and associated lava flows, which lava flows confined between rims of tuff rings and the paleo-valleys. The Fekete-hegy volcanic complex is an example of large, closely spaced phreatomagmatic vent systems that might be common features in small volume intraplate alkaline basaltic volcanic fields. Their development seems to require special paleoenvironmental conditions such as well-drained fluvio-lacustrine basins, and to have substantial deep ground water supply as well as to sustain long lasting phreatomagmatic interaction of ascending magma and water or water rich sediments. In this respect, the Mio/Pliocene volcanic fields in the western Pannonian Basin are exceptionally good examples to study phreatomagmatism and its complex interaction in a fluvio-lacustrine setting as well as point to the transition between small volume intraplate and large volume flood basalt volcanism associated phreatomagmatism.

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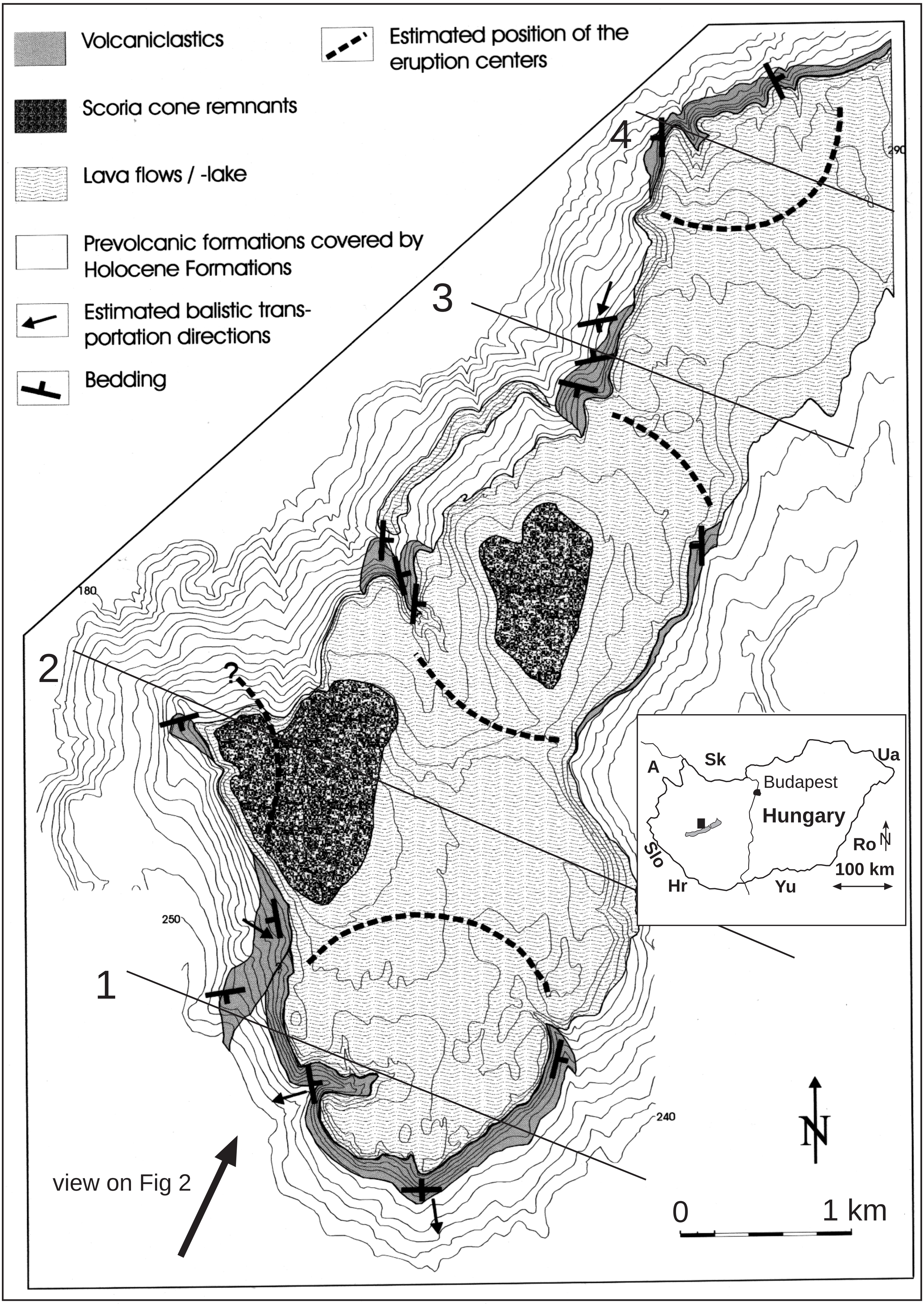
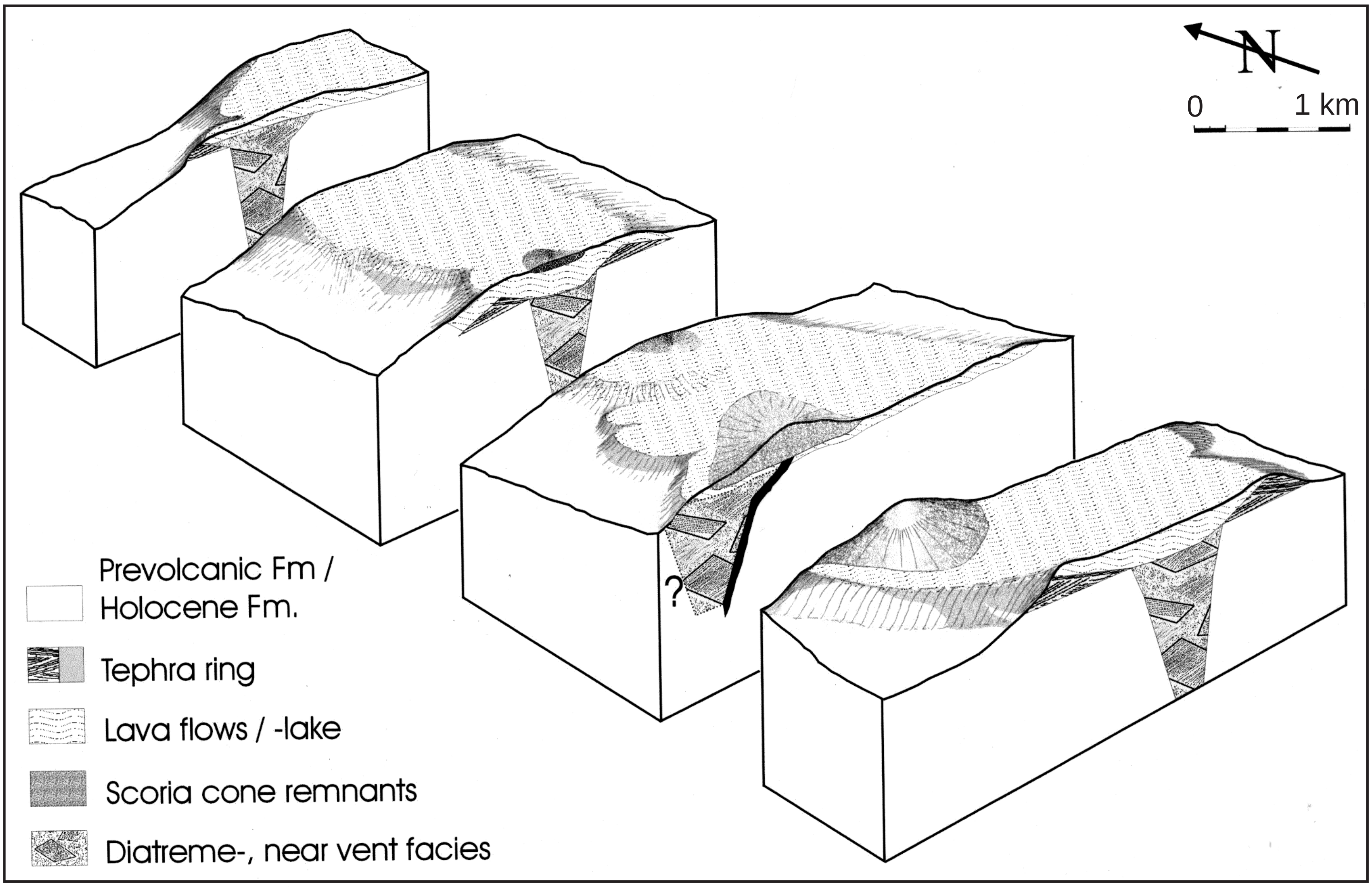
Fig. 1
A simplified geology map of the Fekete-hegy maar volcanic complex. Note the NNE-SSW elongation of the volcanic system and the inward dipping phreatomagmatic pyroclastic beds labelled as “volcaniclastics”.

Fig. 2
A cross sectional view of the volcanic system of Fekete-hegy exhibiting a chain of phreatomagmatic maar-diatreme volcanoes preserved under a tuff ring rim and/or valley confined lava flow field.


Volcaniclastics
Estimated position of the eruption centers
Scoria cone remnants
Lava flows / -lake
Prevolcanic formations covered by Holocene Formations
Estimated balistic transportation directions
Bedding
1
2
3
4
?
180
250
240
290
A
Sk
Ua
Budapest
Hungary
Slo
Ro
Hr
Yu
100 km
N
0
1 km
view on Fig 2


N
0
1 km
?
Prevolcanic Fm /
Holocene Fm.
Tephra ring
Lava flows / -lake
Scoria cone remnants
Diatreme-, near vent facies

Depositional record of a Pliocene nested multivent maar complex at Fekete-hegy, Pannonian Basin, western Hungary.

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