

GLASS SPHERULES IN BADENIAN SILICICLASTICS AND CARBONATES OF N. CROATIA, POSSIBLE RIES CRATER DISTAL EJECTA

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Ries crater of Miocene age (14.74 ± 0.20 Ma [1]) in southern Germany (Fig. 1) is considered the source of Bohemian tektites (moldavites) [2]. Its suevite glasses and associated tektites have been extensively studied by many authors, but distal ejecta was so far unknown, though very likely to occur, given the crater size. The chemical composition of the Ries crater suevite glasses and melts shows predominance of SiO_2 [3] which generally matches the composition of green moldavites [4], although they have originated by melting of different target rocks [5].

We have found glass spherules in Badenian (Middle Miocene, 16.303-12.829 Ma [6]) sediments at three locations in Northern Croatia; in sandstones near Krapina city and in fossiliferous shallow- and deepmarine carbonates at two

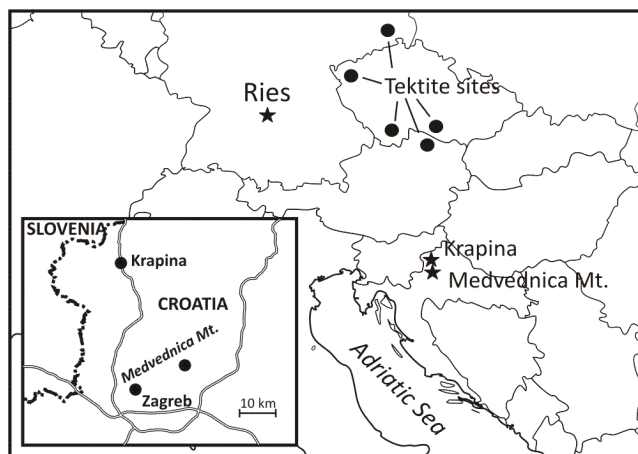


Fig. 1: Location of Ries crater, tektite sites and Croatian spherule sites in map insert (black dots).

localities on Medvednica Mt. near Zagreb (17 km apart), 500-533 km SE from the Ries crater (Fig. 1). Spherules are morphologically identical, 200 - 800 μ in diameter, transparent, and are most abundant at the Krapina locality. The coincidence of their age with the Ries impact makes them good candidates for distal ejecta.

The chemical composition of spherules is shown in Table 1 against the composition of suevite glass and Moldavite tektite. However, one of our suevite samples has considerably larger share of CaO than published [5]. The chemical composition of Krapina spherules generally fits the composition of suevite glass, but has significantly higher amount of Na_2O (11.12 wt %) and C (8.41 wt %). However, the Medvednica Mt. spherules differ from glass and tektites in much lower SiO_2 content (37.65 wt%), but high C (41.95 %) and U (11.13 wt %). The similarity in chemical composition of the Krapina spherules and suevite glass may indicate origin by melting of similar (but not identical) parent rocks, whereas those on Medvednica Mt. were created by melting of currently unknown target rocks which must have been carbon-rich with only small amount of sand, similar to organic lacustrine or marsh deposit.

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References:

[1] Buchner E. et al. 2013. *Zeitschrift der Deutschen Gesellschaft für Geowissenschaften* 164/3: 433-445, [2] Trnka M. and Mouzar S. (2002) *Bulletin of the Czech Geological Survey* 77/4: 283-302, [3] von Engelhart W. (1997) *Meteoritics and Planetary Science* 32: 545-554, [4] von Engelhart W. et al. 2005. *Geochimica et Cosmochimica Acta* 69/23: 5611-5626, [5] von Engelhart W. et al. 1995. *Meteoritics* 30: 279-293, [6] Hohenegger J. et al. 2014. *Geologica Carpathica* 65/1: 55-66.

Table 1: Chemical composition of analyzed samples (wt %)

| | Ries glass (PIXE) | Moldavite (PIXE) | Krapina (EDS) | Medvednica (EDS) |
|-------------------------|-------------------|------------------|---------------|------------------|
| SiO_2 | 52.24-69.44 | 80.6118 | 63.32 | 37.65 |
| Al_2O_3 | 12.75-19.44 | 8.8995 | n.d. | n.d. |
| Fe_2O_3 | 2.80-5.26 | n.d. | n.d. | n.d. |
| CaO | 3.55-24.5 | 3.0641 | 7.00 | 6.18 |
| MgO | 0.47-2.45 | 2.0231 | 3.13 | 1.77 |
| FeO | 2.80-5.26 | 1.3766 | n.d. | n.d. |
| TiO_2 | 0.71-1.32 | 0.2686 | n.d. | n.d. |
| MnO | 0.003-0.14 | 0.0868 | n.d. | n.d. |
| Na_2O | 0.94-2.68 | 0.3586 | 11.12 | 2.63 |
| K_2O | 1.25-5.96 | 3.0838 | n.d. | n.d. |
| CO_2 | n.d. | n.d. | 6.93 | n.d. |
| U | n.d. | n.d. | n.d. | 11.13 |
| C | n.d. | n.d. | 8.41 | 41.95 |