P-T PARAMETERS AND IMMISCIBILITY PHENOMENA IN SYNKINEMATIC FLUIDS OF THE THIN-SKINNED MURÁŇ NAPPE (WESTERN CARPATHIANS)

MILOVSKÝ, R.[1], HURAI, V.[2]
[1] Geological Institute, Slovak Academy of Sciences, Banská Bystrica, Slovakia.
[2] Department of Mineralogy and Petrology, Comenius University, 842 15 Bratislava, Slovakia)
E-mail: milovsky@savbb.sk

The widely accepted model of moving thrust sheet (Hubert and Rubey, 1959) presumes presence of an over-hydrostatically stressed fluid on the base of the block. Such a fluid absorbs all normal stresses, thus facilitates movement of the thrust sheet. Numerous authors have invoked increased fluid pressures along bases of nappes. Some of them (Masson, 1972) have noticed chaotic hydraulic brecciation indicative of a supralithostatic fluid pressures.

Recently, a fluid, which is thought to represent lubricant facilitating the thrust movement, was discovered in carbonatic cataclasites at the base of the superficial Muráň nappe (the Silicicum tectonic unit, Central Western Carpathians) and studied using microthermometry (Milovský et al., 2003, in press).

Synkinematically grown euhedral crystals of quartz (Ø<1,5mm) and K-feldspar (Ø<2mm) recovered from basal cataclasites host primary and secondary fluid inclusions. According to phase ratios at room temperature, several inclusion types have been distinguished:

Class 1 - brine inclusions

Type 1a: Three-phase inclusions composed of aqueous liquid (85-90 vol.%), halite (8-15 vol.%) and vapour bubble (5-13 vol.%).

Type 1b: Four-phase inclusions composed of aqueous liquid (75-85 vol.%), vapour bubble (8-15 vol.%, halite (4-7 vol.%) and sylvite (1-2 vol.%).

Type 1c: Three-to-four-phase inclusions composed of aqueous liquid (80-90 vol.%), halite (10-15 vol.%), CO_2-liquid ± CO_2-vapour (6-15 vol.%).

Class 2 - CO_2-rich inclusions, consisting of CO_2-liquid and/or vapour phases. They coexist with the 1a-type inclusions in both primary and secondary systems.

Class 3 - halite-dominating inclusions, usually coexisting with the 1a- and 1b-type inclusions.

Class 4 - polyphase inclusions (salt melts), composed of 3-4 crystals occupying almost whole inclusion volume, vapour bubble (on cooling splits into CO_2-rich liquid and vapour phases) and small volume of aqueous liquid.

Class 5 - gypsum and anhydrite solid inclusions.

Aqueous inclusions of 1st class homogenize by halite dissolution at temperatures ranging between 213 and 450°C. Salinities of brine inclusions of types 1.a and 1.c range between 32.5 and 56 wt.% NaCl eq., inclusions of the type 1.b contain 38 wt.% NaCl and 22 wt.% KCl. Presence of chlorides of alkali earth elements ($CaCl_2$, $MgCl_2$) is indicated by eutectic temperatures. CO_2-rich inclusions of the 2nd class exhibit distinct depression of triple point, which suggests presence of minor amount of other gaseous phase – probably CH_4 or N_2.

A total of three fluid entrapment modes have been distinguished:

1. Homogeneous trapping of brine (in 1.a and 1.c type FI´s).
2. Heterogeneous trapping of brine and solid halite – L+H – (in 1.b and some 1.a type FI´s).
3. Heterogeneous trapping of brine and dense CO_2-rich phase – L+L – (in coexisting 1.c and 2nd class of FI´s).

Total homogenization temperatures by halite dissolution (246-452°C) in the homogenously trapped inclusions are interpreted to represent minimum possible trapping temperatures. Pressures determined from izo-T_h lines intersecting 40 wt.% NaCl liquidus (Bodnar, 1994) range between 0.2 and 5.4 kbar.

In the L+H heterogeneous systems, the minimum values of total homogenization by halite dissolution (T_mH) represent true trapping temperatures. PT estimates range between 354-410°C and 1.0-3.1 kbar, respectively.

Inclusions corresponding to L+L trapping mode display T_{mH} values of the aqueous inclusions between 409-455°C. Pressure estimated by intersection of the vapour-unsaturated halite liquidus with isochores of coexisting CO_2 inclusions (densities between 0.94 – 1.12 g/cm^3) corresponds to 3.4-5.5 kbar.

Spatial distribution of the pT data is shown on figure 1.

Stratigraphy-based constraints suggest maximum thickness of overburden ~ 3 km in the Muráň nappe, which is in good agreement with weak metamorphic overprint, ~ 180-200°C, according to illite crystallinity. The temperatures inferred from inclusion fluids are thus significantly higher (Milovský et al., 2003). Similarly, the fluid pressures exceed a maximum limit defined by the lithostatic load and the tensile strength of the rocks. The increased temperature accompanied by supralithostatic fluid overpressure was probably caused by frictional heat coincidental with pervasive cataclasis of basal rocks during thrusting. The hangingwall rocks acted as an impermeable seal of the overpressurized fluid domains. Episodic hydraulic fracturing allowed fluid leak-off and pressure drop to hydrostatic values. Wide variations of fluid pressures ranging between $\lambda \sim 0.25$-6.7, as well as immiscibility phenomena record such „catastrophic" events.

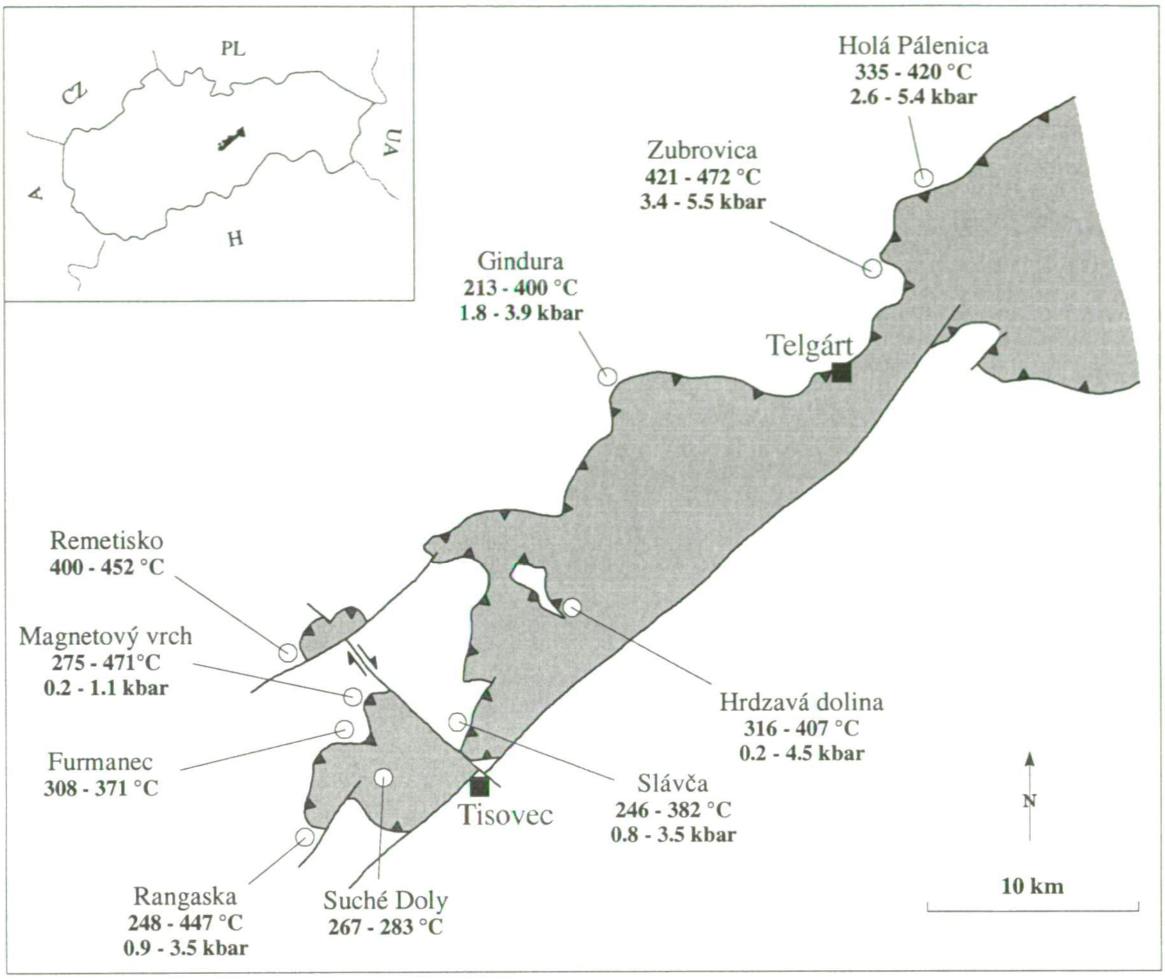

Fig. 1: Simplified sketch of the Muráň nappe showing location of studied samples with estimated *pT* ranges.

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