PEG 2011
ARGENTINA

Asociación Geológica Argentina
Serie D: Publicación Especial Nº 14
ISSN 0328-2767

CONTRIBUTIONS TO THE 5th INTERNATIONAL SYMPOSIUM ON GRANITIC PEGMATITES

CONICET
CCT - MENDOZA

Mendoza, 2011

MAGMATIC LAYERING (UNIDIRECTIONAL SOLIDIFICATION TEXTURES AND Y-ENRICHED GARNET TRAIN TEXTURES) IN APLITE – PEGMATITES OF THE CADOMIAN BRNO BATHOLITH, CZECH REPUBLIC

Hönig Sven[1§], Leichmann Jaromír[1], Novák Milan[1]

[1]*Department of Geological Sciences, Masaryk University, Kotlářská 2, 611 37Brno, Czech Republic* [§] *honig@mail.muni.cz corresponding author*

Key words: Unidirectional Solidification Texture (UST), A-type granite, magmatic layering, aplite-pegmatite, yttrium, garnet, Train texture.

INTRODUCTION

Rarely occurred magmatic structure - Unidirectional solidification textures (UST) - are known as a specific type of the magmatic layering. This non-genetic term describes the morphological features of layers with crystals oriented perpendicular to, or with high angle to, the strike/plan of a layer. Typical morphological features of UST are comb-like or crenulate shape of the crystals oriented perpendicularly to the layer. These crystals are present in layers and multilayered sequences, with textures indicative of mineral growth in one direction from a solid substrate.

The term UST was used for the first time by Shannon et al. (1982) for textures observed in subvolcanic granitic bodies at the Henderson Mine, Empire, Colorado; however, older Russian texts also described identical textural features in the Transbaykal region. Similar textures were recently found in many strongly peraluminous, volatile-rich (B, F and H2O) aplite–pegmatites as well (e.g., London 1992; Breiter et al. 2005).

Compared to these highly-fractionated, micas-bearing and peraluminous aplite-pegmatites the UST were newly found in the felsic, A-type, metaluminous, garnet-bearing aplite-pegmatites of the Brno Batholith, SE Czech Republic (Hönig et al. 2010), studied in this paper.

GEOLOGICAL SETTING

The Brno Batholith is Cadomian magmatic complex formed mainly by amphibole–biotite and biotite granitoids, pegmatites or other more evolved leucocratic granitic rocks are evolved very sporadically, in additional. Three distinct internal subunits were recognized in the Brno Batholith, each separated by sharp tectonic boundaries: Central Metabasite Zone, Eastern Granitoid (*I*-type) Complex and Western Granitoid Complex, inside which three distinctive granitic suites were observed. Two of them are represented by evolved rocks of an active continental margin with affinities to S- and/or I-type granites. The third suite (Hlína suite-studied in this paper), is built by felsic, layered, garnet-bearing, aplite–pegmatite intrusions. Now is classified as A-type granite (Leichmann et al. 1999).

Dykes and lens-shaped bodies of the layered Hlína aplite–pegmatites and associated aplitic granites cut both other S-and I- type granodiorites of the Western Granitoid Complex. The examined aplite–pegmatite bodies are ~2 to 50 m thick and up to 200 m long with a general NW–SE strike and dip 40–80° to the northeast or the southwest. Sharp contacts of the aplite–pegmatite dykes and host granodiorites are only scarcely exposed and commonly strongly weathered.

TEXTURES AND STRUCTURES OF THE HLÍNA LAYERED SUITE

Studied dykes are characterized by alternating of generally fine-grained layered garnet-bearing aplite units containing parallel comb-like coarse-grained UST units (Fig.1). Major minerals of UST include K-feldspar, plagioclase (An 15-10) and quartz, accessory minerals are extremely rare. The tops of elongated crystals are always growing into the fine-grained aplite unit with sharp boundary. For the bottom/opposite sides are typical transitional boundaries. Contacts of both (aplite and UST) units are typically sharp although gradual transitions were also observed. Thickness of the individual zones varies from several cm to cca 1–2 m for aplites and cca 10 cm for UST zones. The layered character of aplitic rocks is pointed up by parallel stripes of Y-enriched garnet grains. This train textures are composed by numerous of small (< 0.5 mm) individual garnet grains always arranged into long lines (up to several meters long), where the individual garnet crystals are in direct contact (Fig.2 a,c,d). Stripes are always parallel to the plane of the aplite unit. Less abundant are similar associated strips of magnetite.

Cathodoluminiscence study of fine-grained aplite unit and coarse-grained UST exhibit several internal structures inside both K-feldspar and plagioclase. Zoned feldspar from aplite unit (Fig.2 e) are very common: K-feldspar, lacking perhithes, are marked by variable intensity of blue color with well developed hourglass sector zoning in their middle parts as well as light blue dissolved sector zones on corroded rims. Subhedral grains of plagioclase (light green color) show multiple oscillatory zones. Feldspars represented in the coarse-grained UST unit have zoned texture too. The comb-like shaped crystals of K-feldspar show light-blue sector luminescence zoning with sharply jagged rims in their centre; no zoning were observed in their dark-blue outer parts.

A different modal composition as well as textural dissimilarity between alternated UST and aplite units is remarkable. The interlayered aplite units seems to have features of very rapid cooling such as hourglass zoning, abundant symplectites-granophyres presented between feldspars and quartz. Unlike UST that show effects of probably slightly slower crystallization because oscillatory zoning of comb-like K-feldspar observed by CL.

WHOLE-ROCK CHEMISTRY

All aplite–pegmatites of the Hlína suite have a felsic character documented by high contents of SiO_2 (74.6–75.7 wt. %), K_2O (4.61–4.94 wt. %), Na_2O (3.82–4.21 wt. %), moderate concentrations of CaO (0.94–1.11 wt. %), and low to very low concentrations of $Fe_2O_3^T$ (0.62–0.93 wt. %), MgO (0.02–0.03 wt. %) and TiO_2 ($\leq$ 0.03 wt. %). Slightly elevated concentrations of Rb (170–182 ppm) and MnO (0.12–0.32 wt. %) are positively correlated with Y and HREE concentrations. Low K/Rb (212–241) and high K/Ba ratios (1034–2303) with deep negative Eu anomalies indicate high degree of fractionation.

Typical is depletion in LREE (cca 10× enrichment over chondritic abundances) relative to HREE (70–90× enrichment relative to chondrite); noticeable is also low contents of volatilies (B,F, P and H_2O).

The ASI of the Hlina suite is moderte (alumina saturation ~ 1.01); affinity to calc-alkaline series (calc-alkali index = 15.1-16.2) is also typical. After tectonic diagrams of Pearce et al. (1984) Hlína aplite-pegmatites plot to the WPG (Within-Plate Granites); Moreover, high content of Y (64-116 ppm), Nb (12-28 ppm) and Ga classify these rocks into the fields of post-collisional, post-orogenic and anorogenic A-type granites (Eby 1992).

CONCLUSSION

Based on discussed above, the crystallization of the magma was probably several time

interrupted (alternation of UST and interlayered aplite units); moreover, the process of non-equilibrium crystallization is characterized by the layered /striped structure of the magmatic Y-rich garnet (spessartine-almandine solution) also with evolved internal oscillatory and sector zoning. Mechanism for formation garnet-rich and garnet-poor layers is considered oscillatory crystallization-related process at the evolving chemical boundary front (process suggested by Webber et al. 1999) formed next to the partly solidified surface of the UST unit. All these features are strikingly different from other known UST-bearing intrusions worldwide, which are typically associated with strongly peraluminous, volatile-rich (B, F, P and H2O) intrusions of distinct mineralogy.

ACKNOWLEDGEMENTS
This work was supported by the research projects GAČR IAA300130801 and MSM0021622412.

REFERENCES

Breiter K, Müller A, Leichmann J, Gabašová A (2005) Textural and chemical evolution of a fractionated granitic system: the Podlesí stock, Czech Republic. Lithos 80: 323–345

Eby GN (1992) The A–type granitoids: a review of their occurrence and chemical characteristics and speculations on their petrogenesis. Lithos 26: 115–134

Hönig S, Leichmann J, Novák M (2010) Unidirectional solidification textures and garnet layering in Y-enriched garnet-bearing aplite–pegmatites in the Cadomian Brno Batholith, Czech Republic. J of Geosciences 55: 81-97

Leichmann J, Novák M, Sulovský P (1999) Peraluminous whole-rock chemistry versus peralkaline mineralogy of highly fractionated, garnet-bearing granites from the Brno Batholith. Ber Deutsch Miner Ges 1: 144

London D (1992) The application of experimental petrology to the genesis and crystallization of granitic pegmatites. Canad Mineral 30: 499–540

Pearce JA, Harris NBW, Tindle AG (1984) Trace element discrimination diagrams for the tectonic interpretation of the granitic rocks. J Petrol 25: 956–983

Shanon on JR, Walker BM, Carten RB, Geraghty EP (1982) Unidirectional solidification textures and their significance in determining relative ages of intrusions at the Henderson Mine, Colorado. Geology 10: 293–297

Webber KL, Simons WB, Falster AU, Foord EE (1999) Cooling rates and crystallization dynamics of shallow level pegmatite–aplite dikes, San Diego County, California. Amer Miner 84: 708–717

FIGURE CAPTIONS

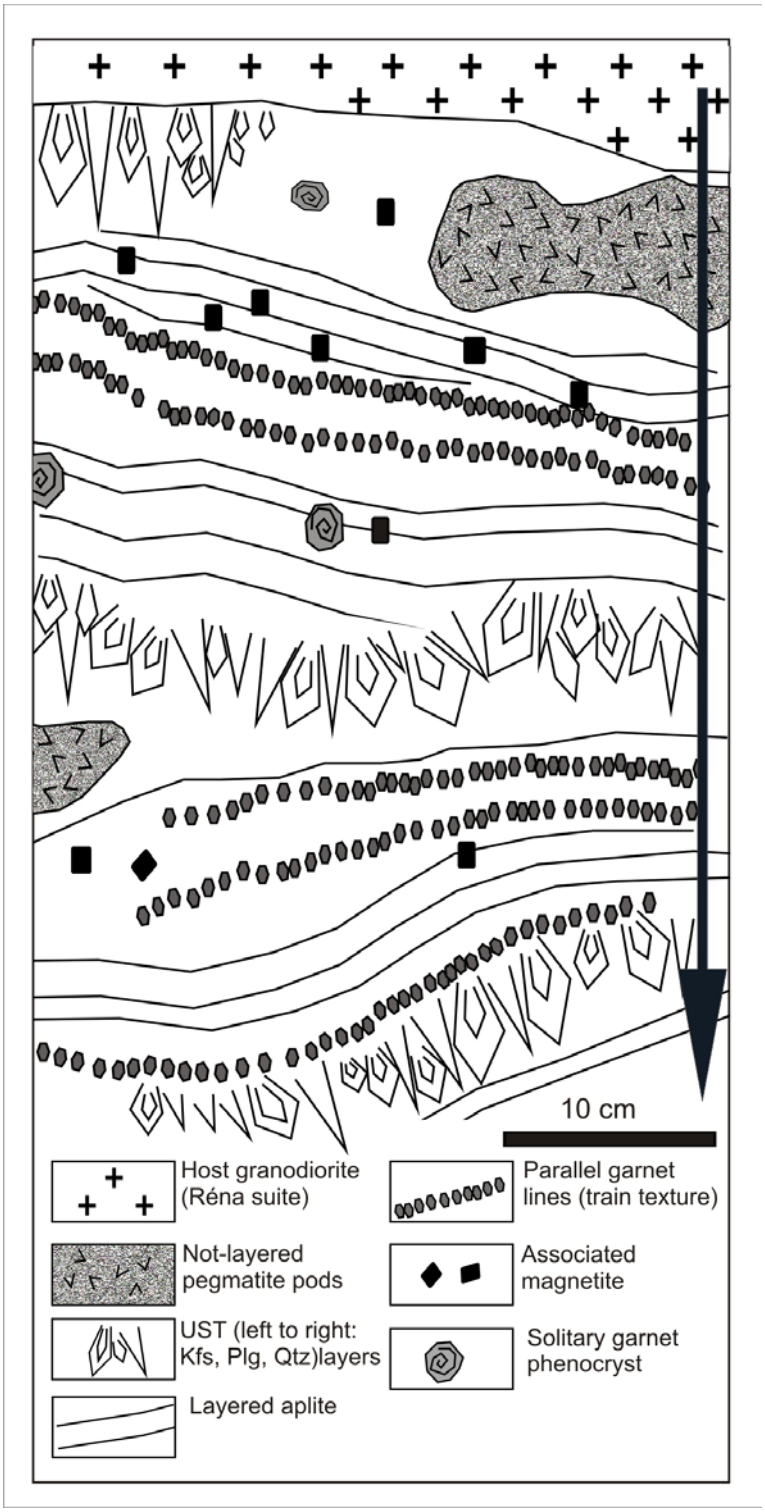

Fig.1
Idealized vertical section of the Hlína layered aplite-pegmatite. Arrow shows direction of crystallization. Individual layers and features are not to scale. Thickness of interlayered aplite typically vary from 0.1 to 0.5 m, UST unites are usually 0.2 – 10 cm thick.

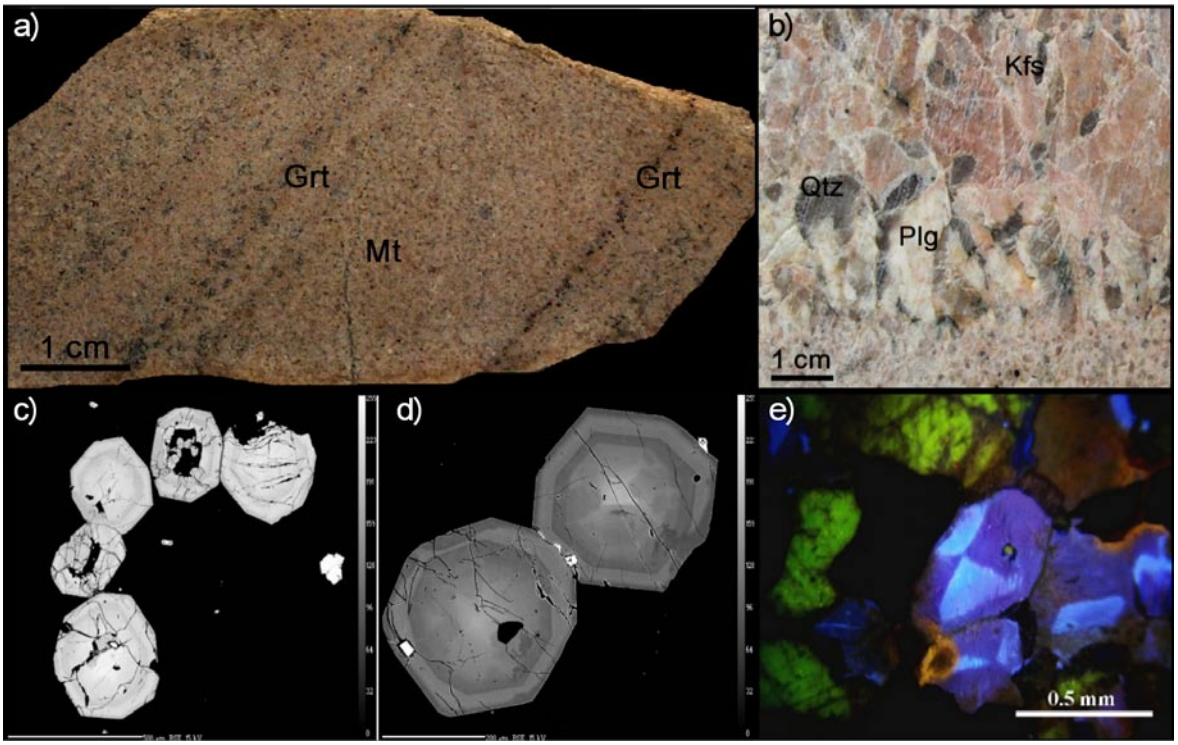

Fig.2
Upper row images – macrotextures of the layered Hlína suite; a – Aplite unit is typical by parallel garnet strips and associated magnetite. b – UST unit characterized by comb-like shaped Kfs, Qtz and Plg. The tops of elongated crystals growing into the fine-grained aplite unit with sharp boundary. Opposite sides of the UST have a transitional boundaries.
Lower row images – structures of garnets (c,d) and feldspars (e); c – BSE image of the train texture, garnets from the strip. d – garnets from strip in BSE, typical is a complex inner fabric (sector zones in the centre, oscillatory zones in the rims). e – CL image of the blue colored hourglass and sector zoning K-feldspar.