Contrastive Strain Record within the Magmatic Fabric in the Land's End Granite (SW England): a Comparative Study of the Orientation Tensor Determined

Zuzana KRATINOVÁ[1], Karel SCHULMANN[1] and František HROUDA[2]

[1] *PřF UK, UPSG, Albertov 6, Praha 2, 128 43 Praha 2, Czech Republic*
[2] *Agico Inc., Ječná 29a, Brno, Czech Republic*

The Lower Permian Land's End Granite, the westernmost pluton of the Cornubian batholith (SW England) reveal complex magmatic flow patterns defined by aligned alkali-feldspar phenocrysts exhibiting meter-scale variations, commonly with respect to the presence of stoped blocks. Structural studies of the host rocks have been used to infer that granite generation and emplacement occurred in response to regional D3 NNW-SSE extension of moderately thickened crust.

Orientation tensor (OT) is a purely mathematical tool for characterizing intensity and pattern of the preferred orientation of minerals in a rock. It can be determined through direct fabric measurements and from the anisotropy of magnetic susceptibility (AMS) measurements (provided that the AMS carrier is a magnetically uniaxial mineral or a mineral for which it holds $k1 - k2 = k2 - k3$, where $k1 > k2 > k3$ are principal susceptibilities). OT fabric was investigated in biotite (using an optical goniometer and through AMS) and in large alkali-feldspar phenocrysts (using an optical goniometer)

The Land's End Granite exhibits low degrees of anisotropy of magnetic susceptibility (AMS) carried by biotite. The AMS foliation generally dips gently to the NW or SE and contains two, near-orthogonal lineations that trend ENE-WSW and N-S. The variations in magnetic lineation orientation correlate with the intensity of the macroscopic feldspar fabric. The resulting comparison of the feldspar and biotite tensors with AMS patterns shows strong concordance between the orientation of biotite zone axis, AMS K1 orientation and orientation of feldspar maximum eigenvector in zones of high intensity of macroscopic feldspar fabric. However, strong deviations of the AMS from the CPO data occur in zones of weak intensity and further from the margins of the host rock.

Domains of perfect concordance between AMS, biotite and feldspar principal directions of the orientation tensor surrounding stoped blocks are marked by the plane strain biotite ellipsoid, while the fabric defined by feldspar is prolate. Domains of subvertical feldspar foliation consistent with the field measurement show the discordant fabric compared to AMS. The ellipsoid defined by biotite is mostly oblate, while ellipsoid defined by feldspar is prolate or plane strain.

These differencies may result from different volumes of measured rocks by two respective methods and consequently the number of measured grains. The other possibility may be in different timing of growth of feldspar population with respect to magnetic minerals. The feldspar fabric is probably related to construction of the magma chamber (large number of strain increments and finite strain memory) while the AMS reflects only final strain increments controlled by host rock and granite margin mechanical coupling.

Flow and Fabric Development during the Diapiric Rise of Magma: AMS Study on Plaster Models

Zuzana KRATINOVÁ[1], Prokop ZÁVADA[1] and František HROUDA[2]

[1] *PřF UK, UPSG, Albertov 6, Praha 2, 128 43 Praha 2, Czech Republic*
[2] *Agico Inc., Ječná 29a, Brno, Czech Republic*

Internal fabric within diapir-like structures was investigated on analogue models by means of anisotropy of magnetic susceptibility (AMS) and 2D finite strain analysis. The fine-grained specularite and magnetite were homogenously mixed into the plaster. The distribution of strain within the whole body was obtained by means of AMS. Single plaster layers were coloured in order to visualize internal flow geometries.

Unique aparature was constructed in order to perform non-scaled analogue models of silicate magma or salt intrusions. This aparature consists of a plexiglas container and a manual squeezer with a calibrated spring that allows to measure imposed pressure. Plaster layer at the bottom of the container was forced to intrude overlying fine-grained (> 0.017 mm) sand through a hole in a board attached to the squeezer. Sand was continuously deposited as the diapir rose up. Different water: plaster mixing ratios resulted in different viscosities. However, measuring exact viscosities on rotary rheometer failed due to centrifuge effect of plaster particles in water.

The most successful model shows a two-phase development of internal structure while the imposed pressure was continuously increased from 710 kg to more than 950 kg together with the height of sand layer. First phase of diapiric rise in this model is terminated by an extrusive flow. Second phase body crosscuts the former intrusion and is marked by intensive shear zones on the boundaries. Pulses in diapiric rise can be recognized in the upper part of the body, which was formed after the brittle overburden succesively failed due to pressure of the rising plaster. Serrated boundaries with inward pointing cusps of the coloured material into the white plaster in the intrusive chimney are traces of the rise of the diapiric head. Sheared boundaries and low internal deformation in the center of the intrusion shows that plaster behaves as a binghemian fluid. For further investigation of diapiric rise and variable shapes of magmatic intrusions, systematic study using plaster will be carried out. Asphalt will be tested as a more promising and suitable material for modelling the emplacement of volcanic rocks.

References

SCHULTZ-ELA D. D., JACKSON M. P. A. and VENDEVILLE B. C., 1993. Mechanics of active salt diapirism. *Tectonophysics*, 228: 275-312.

Volcanism of the Jurassic-Cretaceous Triple-Junction Zone in the Eastern Carpathians

Michal KROBICKI[1], Jan GOLONKA[2], Marek LEWANDOWSKI[3], Marek MICHALIK[2], Nestor OSZCZYPKO[2], Igor POPADYUK[4] and Ewa SLABY[5]

[1] *University of Mining and Metallurgy, Department of Stratigraphy and Regional Geology, Mickiewicza 30, PL-30-059 Kraków, Poland*
[2] *Jagiellonian University, Institute of Geological Sciences, Oleandry St. 2a, 30-063 Kraków, Poland*
[3] *Institute of Geophysics, Polish Academy of Sciences, Ks. Janusza 64, 01-452 Warszawa, Poland*
[4] *Geological Institute of Ukraine; Lviv, Mickiewicza sq. 10*
[5] *Institute of Geology, University of Warsaw, Żwirki i Wigury 93, 02-089 Warszawa, Poland*

General plate tectonic setting

The triple-junction zone was probably formed somewhere in the present day Eastern Carpathian. The Silesian presumably formed the one arm, the second one was represented by its extension into the Rahiv-Sinaia zone and the third one by the Pieniny Klippen Belt-Magura oceanic realm. The exact location and character of this triple-junction and associated volcanism is one of the subjects of the research undertaken by our team.

The Alpine Tethys includes Penninic, Pieniny Klippen Belt and Magura oceanic realm. This ocean was formed as a result of the separation of Gondwana and Laurasia and connected with the Central Atlantic by a system of transform faults originated during the Pangea break-up process (Golonka et al., 2003). The Pieniny Klippen Belt-Magura basin was characterized during the Jurassic time mainly by pelagic facies containing radiolaria and planktonic algae *Nannoconus*. The submarine Czorsztyn Ridge separated the Pieniny Klippen Belt and Magura subbasins. During Late Jurassic – Early Cretaceous time the Outer Carpathian rift were developed with the extensional type of volcanism. The Silesian Basin originated as a result of the rifting process. The emerged Silesian Ridge (cordillera) separated the Silesian and Magura basins as a result of the fragmentation of the European platform in this area. The subsidence in the Silesian Basin (Oszczypko et al., 2003) was accompanied by the extrusion of basic lavas (teschenites) in the Western Carpathian and the extensive volcanism in the Eastern Carpathians. The Jurassic separation of Bucovino-Getic microplate from European plate is perhaps related to the origin of the Silesian Ridge. The direct connection is obscured however by the remnants of the Transilvanian Ocean in the area of the eastern end of the Pieniny Klippen Belt Basin. These remnants are known from the Inacovce-Krichevo unit in Eastern Slovakia and Western Ukraine. Results of the paleomagnetic research in the Pieniny Kliippen Belt of the Western Ukraine (Lewandowski et al., 2003) shed more light on the dynamic evolution of the basin stretching between Eurasia and Africa-derived Alcapa terrane. They show initially rapid opening (20 cm/y) and then gradual closure of the Pieniny Klippen Belt-Magura oceanic realm in the Late Jurassic time.

Major plate reorganiztion happened during the Tithonian time. The new Atlantic spreading entered the area between the New Foundland shelf and Iberia. The closure of the Meliata-Halstatt Ocean is related to the cessation of spreading in Atlantic Tethys. The Jurassic Alpine Tethys system was abandoned. The change was accompanied by the presumed origination of subduction zone along the margin of the Pieniny Klippen Belt Basin. The age, character and polarity of the presumed subduction are not fully explained. We were assuming the southern dipping of the type B subduction and its location under the southern margin of the Pieniny Klippen Belt Basin. The northern dipping of the subduction and its location under the northern margin of the Pieniny Klippen Belt Basin is also possible. The subduction type B depends on the existence of the oceanic crust, otherwise the type B would occur.

Volcanic sequences

The Eastern Carpathian Mesozoic volcanic sequences are known from the Chivchin – Rahiv ridge (basalts); Uglia (basalts), the Trostianets (basalts, andesites, trachytes) and Vulhovchik streams trough (trachydolerites) as well as from the Transcarpathian depression (basalts, diabases, picritic tuffs). They occur within several tectono-facial units of the Transcarpathian part of the Western Ukraine Carpathian arc. Different path of magma generation within MORB, subduction (A and B) regime (including back arc) as well as stimulated by hot spot allows for recognition various geotectonic environments. This is because products of the appearing magmatism reflect precisely evolution of the events. The research work on geodynamic evolution and on paleogeography of the Polish part of Carpathian during Neo-Cimmerian time (Golonka et al., 2003) showed, that Mesozoic volcanism of the area could be related to complicated development of rift and subduction environments. A setting associating features of both of them is back-arc basin. Evolution of back-arc basins includes magmatic activity showing rift characteristic (inducted by rising mantle diapir) as well as subduction characteristic. The first possibility is supported by some of the volcanic sequences displaying pattern similar to MORB (Lashkevitsch et al., 1995, Varitchev, 1997, Medvedev and Varitchev, 2000). On the subduction-related magmatism could point the LILE behavior in some other sequences occurring in the Eastern Carpathians