P-T-d path of chloritoid schist of the Tethyan Sedimentary Sequence (SE Tibet)

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The Tethyan Sedimentary Sequence (TSS) is characterized by a sequence spanning from Lower Paleozoic to Eocene deposited on the Indian passive margin. The TSS is bounded by the South Tibetan Detachment System (STDS) that puts it in contact with the lower Greater Himalayan Sequence, and by the upper Great Counter Thrust getting it in contact with the Lhasa batholit.

In SE Tibet the TSS is mainly represented by a Triassic flysch (Antolin et al., 2010) deformed under very-low to low-grade metamorphic conditions (Crouzet et al., 2007, Dunkl et al. 2011).

Most of the attention has been paid till now to the relations between the TSS and the STDS (Godin 2003; Carosi et al., 2207; Kellet and Godin, 2009) focusing on the relations between the development of several generations of folds and the activity of this important tectonic discontinuity.

In the study area two main deformation phases have been recognized both of them developed in a contractional tectonic setting. The first tectonic phase (D1) is related to the development of south-facing F1 fold with related axial plane foliation, while the D2 phase is associated to north verging F2 folds and backthrusts. The further tectonic evolution is characterized by the development of brittle-ductile shear zones often localized on the inverted limbs of F2 folds. Kinematic indicators are mainly represented by S-C structures and point to a top-to-the-north sense of movement.

During this work we focused on the early P-T-d evolution of Chloritoid bearing schist sampled SE of Lhasa (Gyatsa area), where a quite complex relationships between deformation and mineral growth has been observed.

Microstructural analyses led to recognize a much more complex structural framework for the D1 tectonic phase. The early development of S1 foliation (S1a), classified as a continous foliation, is associated to the recrystallization of white mica and chlorite, followed by the synkinematic growth of chloritoid, white mica and chlorite defining a spaced to continous foliation, S1b, interpretated as composite foliation during D1. Locally, decussate chloritoid, overgrowing S1b is also observed, testyfing a complex (continous) growth of this mineral from late S1a up to post S1b. Moreover, chloritoid grains are optically zoned, with an inclusion rich greenish core and pale-green rim.

The late foliation (S2) is a spaced foliation, where pressure solution is the main deformation mechanism, associated with locally passive rotation of micas grains.

A detailed SEM-EMPA mineral chemistry work has been done in order to quantify any chemical difference between grains in different position and any chloritoid zoning. SEM based chemical maps and EMPA profiles reveal how a core to rim increase of Mg, compensate by decrease of Fe and Mn, systematically present in chloritoid (XMg from 0.12 up to 0.17). Moreover, white mica shows a statistically change in composition as function of microstructural position, where S1a white micas have a lower Si^{4+} (3.02-3.07 a.p.f.u.) content respect to S1b white micas (3.09-3.15 Si^{4+} a.p.f.u.).

Cite as: Montomoli et al., 2014, P-T-d path of chloritoid schist of the Tethyan Sedimentary Sequence (SE Tibet), in Montomoli C., et al., eds., proceedings for the 29th Himalaya-Karakoram-Tibet Workshop, Lucca, Italy.

A P-T pseudosection in the MnO-Na_2O-CaO-K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O-TiO_2 model chemical system, constructed with the software Perple_X (Connolly, 1990), shows how the P-T condition of S1a equilibration is close to 0.45-0.50 GPa / 400-425 °C, while the P-T condition of S1b developing is around 0.75-0.80 GPa / 500-530 °C. Virtually the same temperature of 510-540 °C have been obtained with the empirical chloritoid-chlorite Fe-Mg exchange thermometer of Vidal et al., (1999) for the chloritoid rim, while the lack of suitable chlorite grains in the core of the chloritoid prevents the application of this thermometer for the chloritoid core.

These observations suggest an increase of P as well as T (buring) during the D1 tectonic event.

References

Antolín, B., Appel, A., Montomoli, C., Dunkl, I., Ding, L., Gloaguen, R., El Bay, R., 2011, Kinematic evolution of the eastern Tethyan Himalaya: Constraints from magnetic fabric and structural properties of the Triassic flysch in SE Tibet. In: J. Poblet and R. Lisle, Editors, Kinematic Evolution and Structural Styles of Fold-and-Thrust Belts, Geological Society of London Special Publications, 349, 99-121 DOI 10.1144/SP349.6

Carosi, R., Montomoli, C. and Visonà, D., 2007, A structural transect in the Lower Dolpo: insights on the tectonic evolution of Western Nepal, Journal of Asian Earth Sciences, 29, 407-423.

Connolly, J.A.D., 1990, Multivariable phase diagrams: an algorithm based on generalized thermodynamics, American Journal of Science, 290, 666-718.

Crouzet, C., Dunkl, I., Paudel, L., Arkai, P., Rainer, T. M., Balogh, K. and Appel, E., 2007, Temperature and age constraints on the metamorphism of the Tethyan Himalaya in Central Nepal: a multidisciplinary approach, Journal of Asian Earth Sciences, 30, 113-130.

Dunkl, I., Antolín, B., Wemmer, K., Rantitsch, G., Kienast, M., Montomoli, C., Ding, L., Carosi, R., Appel, E., El Bay, R., Xu, Q. and von Eynatten, H., 2011, Metamorphic evolution of the Tethyan Himalayan flysch in SE Tibet, In: R. Gloaguen and L. Ratschbacher, Editors, Growth and Collapse of the Tibetan Plateau, Geological Society of London Special Publications, 353, 45-69. DOI: 10.1144/SP353.

Godin, L., 2003, Structural evolution of the Tethyan sedimentary sequence in the Annapurna area, central Nepal Himalaya, Journal of Asian Earth Science, 22, 307-328.

Kellet, D.A. and Godin, L., 2009, Pre-Miocene deformation of the Himalayan superstructure, Hidden valley, central Nepal. Journal of the Geological Society, London, 166, 1-14, doi: 10.1144/0016-76492008.

Vidal, O., Goffé, B., Bousquet, R. and Parra, T., 1999, Calibration and testing of an empirical chloritoid-chlorite Mg-Fe exchange thermometer and thermodynamic data for daphnite, Journal of Metamorphic Geology, 17, 25-39.