Putting all the letters in *P-T-A-X-d-t*

IGOR M. VILLA[1,2]

[1]Institut für Geologie, Univ. Bern, 3012 Bern, Switzerland
[2]Università di Milano Bicocca, 20126 Milano, Italy

Ages of mineral chronometers can vary as a function of:

Pressure *P*. Diffusivity *D* decreases when *P* increases. Small effect, compared to the other letters.

Temperature *T*. Everything goes faster when *T* increases. Just how important this is will be seen below.

Water activity *A*. It enables dissolution-reprecipitation, without which no medium-T metamorphic paragenesis can form [1]. It overruns every other process and has a very weak temperature dependence [2].

Molar fraction *X*. It determines the stability fields in pseudosections. Destabilized mineral chronometers are reset, stable ones mostly not [3].

Deformation *d*. By promoting recrystallization it resets mineral ages at low *T* while samples a few m away preserved old ages at high *T* [4,5].

Age *t*. Intra-mineral age variations recognized by spatial resolution and/or stepwise release ("SR/SR") help us understand the respective roles of *P,T,A,X,d*. [6]

Diffusive losses can occur in some cases [3,7] and are diagnosed by characteristic intra-grain bell-shaped profiles [8,9]. Irregular textures require high *A* independently of *T*. As chronometers record the event that reset them most efficiently, patchy minerals are a poor thermochronometer but a good hygrochronometer. The special role of petrologic equilibrium [10] is easily summarized: equilibrium = maybe diffusion, disequilibrium = certainly retrogression & recrystallization. Partly retrogressed phases (orthoclase/adularia, phengite/paragonite/muscovite, biotite/chlorite, allanite/monazite, etc) require not only age acquisition by SR/SR but above all the diagnose of heterochemical replacement [11, 6].

Retrogression reactions depend on *PTAXd*; the dependence of *t* on *T* is subordinate and never unique.

[1] *Rev Mineral Geochem* **70** (2009) 87 [2] *Science* **222** (1983) 413 [3] *J Petrol* **52** (2011) 691 [4] *Geochim Cosmo-chim Acta* **101** (2013) 24 [5] *J Petrol* doi:10.1093/petrology/egu007 [6] Harlov & Austrheim, *Metasomatism and the Chemical Transformation of Rock*. Springer, Heidelberg, ISBN **978**-3-642-28393-2, p. 171-202 [7] *Earth Planet Sci Lett* **170** (1999) 141 [8] *Contrib Mineral Petrol* **142** (2002) **416** [9] *Lithos* 88 (2006) 1 [10] *Geol Soc London Spec Pub* **332** (2010) 1 [11] *Ann Rev Earth Planet Sci*[2] (2007) 137