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Measurement of local strain rates in ductile shear zones: a new approach from deformed syntectonic dykes.

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On the Earth surface, deformation is mostly localized in fault zones in between tectonic plates. In the upper crust, where deformation is brittle, the faults are narrow and produce earthquakes. In contrast, deformation in the lower ductile crust corresponds to larger shear zones. If it is relatively easy to measure *in situ* deformation rates at the surface using for example GPS data; it is much more difficult to determinate *in situ* values of strain rate in the ductile crust. Such strain rates can only be estimated in paleo-shear zones.

In paleo-shear zones, various methods have been used to assess paleo-strain rates. Cooling and/or decompression rates associated with hypothesis on geothermic gradients and shear zone geometry can lead to the estimation of paleo-strain rates. More direct estimates result from the age determination of helicitic garnets or syntectonic fibres. However, these techniques have been developed in area with little deformation and not in major shear zones. Another way to estimate strain-rates is to associate paleo-stress measurements with a power flow law. However, this implies strong assumptions on the deformation temperature as well as on the parameters of the power flow law.

Here, we propose a new direct method to obtain local strain rates on shear zones, coupling quantification of deformation and geochronology. In order to validate our method, we choose to test it in a major shear zone which tectonic setting is now well constrained: the Ailao-Shan - Red River Shear Zone (ASRRsz) in SE Asia. For this 10 km wide shear zone, large–scale fault rates, determined in three independent ways, imply strain rates between 1.17 * 10^{-13} s^{-1} and 1.52 * 10^{-13} s^{-1} between 35 and 16

Ma.

In outcrops where several generations of syntectonic dykes are present, the strain rate can be measured by quantifying the deformation and the age of each dyke. On one hand, we used a method of surface restoration to quantify the stretching and the shear strain γ of boudins trails corresponding to former dykes. In the ASRRsz, previous studies gave values of $\gamma = 5.5 \pm 1.8$ and $\gamma = 7 \pm 2.8$ for such syntectonic dykes. On the other hand, we determined the emplacement age of each dyke, by ion microprobe U-Pb dating of both zircon and monazite. The strain rates deduced from these measurements will be compared with those previously deduced from indirect methods.

From quartz paleo-piezometer, shear stresses in the ASRRsz are estimated between 15.62 and 34.06 MPa. These shear stresses and strain rates will be compared to results from thermo-mechanical numerical models of the ASRRsz, taking into account the fault rate and the effect of shear heating at the scale of the lithosphere.