Forearc hyperextension by detachment faulting and ophiolite dismemberment: examples from the Yarlung-Zangbo suture zone (Southern Tibet)

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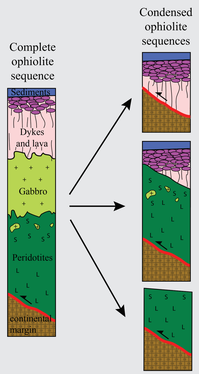
Conclusions

Paleomagnetic and field geological evidence show the preservation of low-angle, extensional **detachment faults** within the Lower Cretceous ophiolites of South Tibet. These structures developed in response of '**forearc hyperextension**', a process that we define as extensive stretching of the overriding plate above a subduction zone associated to a magma-starving spreading center. We propose that forearc hyperextension is the key mechanism responsible for the poorly understood **dismemberment** of the South Tibetan ophiolites.

Aim

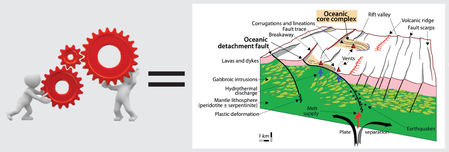


Supra-subduction zone (SSZ) ophiolites are relics of oceanic forearcs frequently preserved as discontinuous belts composed of discrete ophiolitic massifs. They usually contain incomplete, condensed sections compared to typical oceanic lithosphere. These features are frequently attributed to dismemberment, but the tectonic causes of this process remain poorly constrained.

The aim of this study is to analyze the potential causes and mechanisms of ophiolite dismemberment. In particular we tested the role of oceanic detachment faults, which can be preserved in ophiolites as fossil structures (*Maffione et al, 2013; Liu et al., 2014*). We will try to address the following questions:

Can oceanic detachment faults form within SSZ ophiolites and contribute to their dismemberment?

If so, what are the driving mechanisms for their formation?



Methods

- Field analyses at two ophiolite massifs from the Lower Cretaceous South Tibetan ophiolite belt;
- Paleomagnetic analysis of crustal blocks displaced by major faults;
- Rock magnetism, optical and electron microscopy, and elemental analyses;
- Fault kinematic analysis using the paleomagnetic vectors within a Monte Carlo approach;

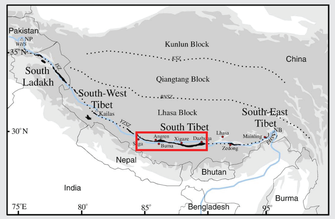


Figure 1. Distribution of the South Tibetan ophiolites (black colour), and location of the study area (red box).

Results

Main finding from field analysis:

- 125-120 Ma forearc Xigaze Group sediments (locally) unconformably cover a dismembered ~130 Ma ophiolite;
- Major faults (red lines in Fig. 2b and 2e) cut the ophiolite but not the Xigaze Group, and are therefore odler than ~120 Ma;
- The studied faults have features compatible with oceanic detachments;

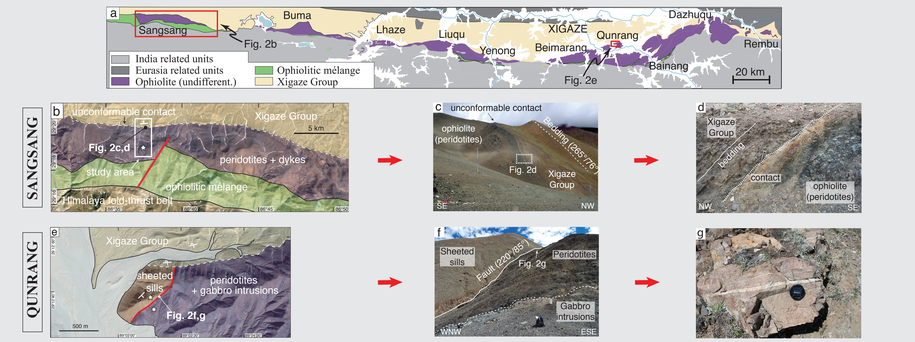


Figure 2. (a) Overview of the Xigaze ophiolites within the South Tibetan ophiolite belt. (b) Geological map of the Sangsang ophiolite. (c,d) Detail of the field relationship between the ophiolite and overlying forearc sediments of the Xigaze Group. (e) Geological map of the Qunrang ophiolite. (f) Faulted contact between the sills and peridotites in the Qunrang ophiolite. (g) Mylonitic structure of the fault plane.

Main finding from paleomagnetism:

- Remanence is carried by high blocking temperature (> 520ºC) low-Ti titanomagnetite of primary origin;
- Different mean paleomagnetic directions across the studied faults reveals the occurrence of relative tectonic rotations;

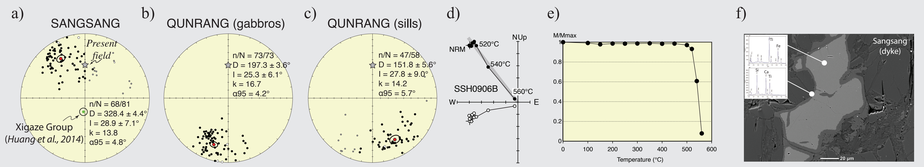


Figure 3. (a,b,c) Equal area stereographic projections of the characteristic remanent magnetization (ChRM) directions of the studied rocks, showing the mean direction (red dots) and relative values. (d) A representative Zijderveld diagram. (e) Decay of magnetization during thermal removal of the remanence. (f) Photomicrograph of a primary titanomagnetite grain with a Ca-rich rim from the Sangsang dykes.

Main finding from fault kinematic analysis:

- Sub-horizontal original (pre-collision) rotation axes associated to a 40-90° of rotation;
- Kinematics comparable to those of oceanic detachment faults;

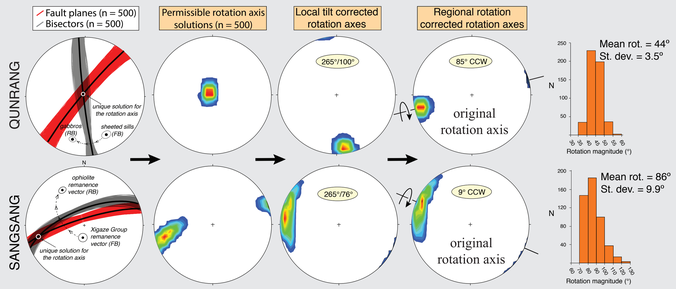
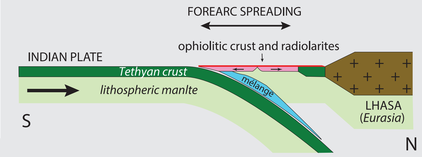


Figure 4. Stereonets showing contour of the 500 permissible rotation axes calculated for the studied faults within the Sangsang and Qunrang ophiolites using a Monte Carlo simulation. The 500 permissible angles of rotation at each site are shown by the frequency distribution diagrams.

Tectonic model for forearc hyperextension

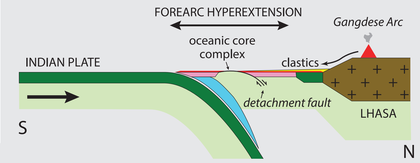
~ 130 Ma

A thin ophiolitic crust with a SSZ affinity was produced at a magma-starving spreading center located at the southern margin of Lhasa;



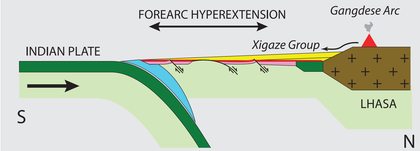
~130-125 Ma

Strong stretching in the upper plate (forearc hyperextension) controlled by the subducting slab dynamics was accommodated by detachment faults; first clastics from the Gangdese arc were deposited over the forearc;



~125-120 Ma

Forearc hyperextension possibly coupled with arc-parallel stretching determined complete dismemberment of the forearc where the ophiolite were generated; forearc sediments of the Xigaze Group covered an already disrupted, thin ophiolite;



Acknowledgments

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