Complex tectonic-thermal history of the Red River Shear Zone: Evidence on Zircon SHRIMP and LA-ICP-MS dating of the Yaoshan Group, SE Yunnan, China

LIU Y-P[1], LI Z-X[2], LIAO Z[1], YE L[1], PI D-H[1] AND LI C-Y[1,3]

[1]State Key Laboratory of Ore Deposit Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang 550002, China (liuyuping@vip.gyig.ac.cn)

[2]Department of Applied Geology, Curtin University of Sciences and Technology, Bentley, WA6102, Australia (Z.Li@curtin.edu.au)

[3]Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China (lcy5736@gig.ac.cn)

The Yaoshan Group is located on the southeastern part of the Ailao Shan-Red River strike-slip fault zone. It has experienced the high-amphibolite facie metamorphism and chorismitization, thus it was thought as one part of the Precambrian basement of the South China Block in the traditional Chinese literatures. According to CL images and optical microscope analysis, the zircons derivered from the Yaoshan Group, which are very complicated with the metamorphosed recrystal and overgrowth, could be divided into inherited, metamorphic, anatectic or magamatic types. In order to probe the history of the Red River Shear Zone, zircons derived from the Yaoshan Group have been dating through SHRIMP and LA-ICP-MS. The inherited zircon yielded the $^{206}Pb/^{238}U$ ages in the range of 235±1.7 Ma and 261±3.6Ma with the weighted mean value of 250.8±9.8Ma (N=4, MSWD=4.1) , suggested that the protoliths of the Yaoshan Group should be a sedimenrary series youger than the Permain period. The $^{206}Pb/^{238}U$ ages of metamorphic, anatectic/magmatic zircons could be divided into five groups, which are ~85 Ma, ~75 Ma, ~43 Ma, ~37 Ma and ~32 Ma, respectively. The five zircon age groups mention above could be taken as important episodes of five intensive activities in Red River fault. The first and second age groups, which related to two magmatic and high-temperature metamorphic episodes, indicated that the Red River Fault acted since the later Cretaceous. The other three age groups, which corresponded with the dating of the Ailaoshan region and North Vietnam, might indicated the three main left-direction activities in the Red River Shear Zone.

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Surface structures on rutile guide organic molecule attachment

K.J.T. LIVI[1]*, B. SCHAFFER[2,3], D. AZZOLINI[1], T. HARDCASTLE[4], C.R. SEABOURNE[4], A.J. SCOTT[4], D. SVERJENSKY[1,5], R. HAZEN[5] AND R. BRYDSON[4]

[1]Johns Hopkins Univ., Baltimore, MD 21218 USA (*correspondence: klivi@jhu.edu)

[2]SuperSTEM Laboratory, Warrington WA4 4AD, UK

[3]University of Glasgow, Glasgow G12 8QQ, UK

[4]SPEME, University of Leeds, Leeds LS2 9JT, UK

[5]Geophysical Laboratory, Washington, DC 20015 USA

Interactions of aqueous organic molecules with the surfaces of metal oxides, such as rutile, are of fundamental interest in a wide range of topics from human implants to the origin of life on Earth. Previous adsorption studies of metals and organic molecules have focused on the {110} form that often dominates macroscopic crystals. However, recent experimental and theoretical studies of glutamate and aspartate adsorption on a synthetic rutile are consistent with attachment to functional groups such as >Ti (OH)2 or >Ti (OH)O which are not present on ideal {110} surfaces but are instead present on the pyramidal {111) or {101} surfaces [1, 2]. The pyramidal forms would have to be sufficiently abundant as steps on {110} to account for the measured adsorption of amino acids. We have used aberration-corrected atomic-resolution scanning transmission electron microscopy high-angle annular dark-field (HAADF) imaging to locate surface Ti atoms and determine the structures present on {110} and {111} faces. HAADF images of {110} prism edges show three structures: Ti-Ti pairs parallel to {110}, {111}, and {11-1} edges. The proportion of these are 4:1:1, respectively, regardless of the roughness of the edges on the μm-scale. This also matches the proportion of crystal prism to pyramidal face lengths. The majority of surface structures consist of only half unit-cell steps. These half steps comprise about 33% of the {110} prism edges. If these extend across the {110} faces, they could account for the sites necessary for amino acid adsorption. Interestingly, odd numbers of Ti pairs between steps requires that bounding steps have different structures not related by symmetry. The calculated energies of the (110) (0.40 J/m2) and (111) (1.41 J/m2) surfaces are also nearly 4:1, suggesting a relationship between growth rate and surface energy. We conclude that: (1) the presence of {111}-type steps on {110} confirms inferences from theoretical and experimental adsorption studies, (2) adsorption models and experiments can be integrated with sub-unit cell surface structures, the detailed nature of which should be characterized with electron microscopy.

[1] Jonsson *et al*. (2009) *Langmuir* **25**, 12127–12135. [2] Park *et al*. (2011) *Langmuir* **27**, 1778–1787.