

## Effect of Oxalic Acid on Geological Storage of CO<sub>2</sub> Using Serpentinite

SEUNG-HEE KANG<sup>1\*</sup>, NATALIE C. JOHNSON<sup>2</sup>, BURT THOMAS<sup>3</sup>, KATE MAHER<sup>1</sup>, DENNIS K. BIRD<sup>1</sup>, ROBERT J. ROSENBAUER<sup>3</sup>, AND GORDON E. BROWN, JR.<sup>1</sup>

<sup>1</sup>Stanford University, Geological & Environmental Sciences, envlover@stanford.edu (\*presenting author)

<sup>2</sup>Stanford University, Chemical Engineering, nataliej@stanford.edu

<sup>3</sup>United States Geological Survey, burt.thomas@gmail.com

Mineral carbonation of Mg-silicates ensures stable CO<sub>2</sub> storage over geologic time periods. This reaction takes place in natural systems but is kinetically slow [1]. In order to make mineral carbonation an efficient means of sequestering CO<sub>2</sub>, we have investigated the effect of oxalic acid in enhancing the kinetics of the serpentinite-CO<sub>2</sub>-H<sub>2</sub>O reaction.

Serpentinite used in this study was obtained from the New Idria, California serpentinite massif and consists primarily of antigorite. For faster reaction, the rock was ground and sieved, and the 60 to 150 μm size range was separated. After washing with methanol five times, the serpentinite was characterized by XRD, XPS, SEM-EDX, and XRF.

Our experiments were conducted under 100 bars CO<sub>2</sub> at 60°C in 0.5M NaCl solution for one month with a water-to-rock mass ratio of 20:1. A Dickson-type rocker bomb reactor used for these experiments is able to maintain constant pressure and temperature while samples are withdrawn at regular intervals. Thorough mixing was achieved by rocking the reactor.

Magnesite and siderite were generated within 25 days, as revealed by XRD and SEM/EDX analyses. SEM and EDX analysis showed widely dispersed magnesite on the edges of serpentinite grains. Siderite, although less abundant than magnesite, showed more euhedral shapes. The overall carbonation reaction was enhanced in the presence of oxalic acid.

Solution pH was calculated from alkalinity and was found to increase from 3.0 to 5.3 within two days as H<sup>+</sup> was consumed during Mg<sup>2+</sup> dissolution from serpentine. The serpentinite surface was positively charged under all experimental pH conditions as revealed by zeta potential measurements, suggesting that oxalate anions are likely to be electrostatically attracted to the particle surfaces. Therefore oxalate is predicted to form Mg- and Fe-complexes, which should enhance dissolution. The amounts of Mg, Ca, Fe, and Si released during dissolution were quantified using ICP-OES and indicate initial incongruent dissolution (excess concentrations of Mg, Ca, and Fe, relative to Si). The Mg and Fe concentrations along with pH changes in this experiment indicated favorable conditions for magnesite and siderite formation. Although Krevor and Lackner discussed enhanced serpentine dissolution in the presence of oxalate for CO<sub>2</sub>-H<sub>2</sub>O-serpentine reaction [2], the present study presents new data on both Mg dissolution and magnesite formation, which will be presented.

[1] P. B. Kelemen and J. M. Matter, *In situ* carbonation of peridotite for CO<sub>2</sub> storage. *PNAS* **105** (2008) 17295-17300.

[2] S. C. Krevor and K. S. Lackner, Enhancing process kinetics for mineral carbon sequestration. *Energy Procedia* **1** (2009) 4867-4871.

## The Volcanic Rocks of Bima Formation, Sangri Group in Gangdese Belt: Products of Intra-Oceanic Subduction

ZHI-QIANG KANG<sup>1\*</sup>, JI-FENG XU<sup>2</sup>, DI-CHENG ZHU<sup>3</sup>, JIN-LIN CHEN<sup>3</sup>, ZUO-HAI FENG<sup>1</sup>, XI-JUN LIU<sup>1</sup>, BING-KUI MIAO<sup>1</sup>, BAO-CHENG PANG<sup>1</sup>, WEI FU<sup>1</sup>, QING-WEI ZHANG<sup>1</sup>

<sup>1</sup>College of Earth Sciences/Guangxi Key Laboratory of Hidden Metallic Ore Deposits Exploration, Guilin University of Technology, Guilin 541004, China, zk99201@163.com (\*presenting author)

<sup>2</sup>State Key Laboratory of Isotope Geochemistry, GIG, CAS, China

<sup>3</sup>School of Earth Sciences and Resources, CUGB, Beijing, China

The Sangri group volcanic rocks lie in Middle-Eastern part of south edge of Gangdese belt, thought to be the production of Neo-Tethys' northward subduction. However, its geochronology, feature and tectonic setting remains a debate. The previous researches mainly focus on the underlying Mamuxia formation, which originated from the melting of subducted oceanic crust<sup>[1,2]</sup>. But so far, there is not any study about the overlying Bima formation, so in this study, we focus on the Bima formation and acid intrusions in Sangri group, in order to understand its petrogenesis, tectonic setting and constrain the age and evolution of the whole Sangri arc. The two conclusions as following:

1. We selected zircons from the acid intrusion to do LA-ICPMS U-Pb dating, obtaining an age of 93.4±1.1Ma, which can constrain the upper limit of Sangri group's age. Combining our new data with previously zircon SHRIMP U-Pb age of andesite from the underlying Mamuxia formation by Zhu<sup>[2]</sup>, we firstly obtain the activity time of Sangri group, from 136.5Ma to 93.4Ma.

2. Bima formation mainly consists of basalt, basalt-andesite and andesite. We chose the most mafic rocks to discuss magmatic origin and tectonic setting. These rocks are tholeiite basalt, with high Al<sub>2</sub>O<sub>3</sub> (average 17.72wt%), MgO (average 7.82wt%), Mg # (average 65.52), Cr (215ppm) and Ni (140ppm), hinting that the magma did not undergo significant differentiation. In the spider diagram its geochemical characteristics are similar with those of island arc volcanic rocks, e.g., the enrichment of LILE and depletion of HFSE. However, the basalts have very low K<sub>2</sub>O (average: 0.13wt%)、Th (average: 0.8ppm) and flat REE pattern (La<sub>N</sub>/Sm<sub>N</sub>=1.37; La<sub>N</sub>/Yb<sub>N</sub>=2.12), the initial Sr<sup>87</sup>/Sr<sup>86</sup> ratios vary in range of 0.703965~0.704316, while Nd<sup>143</sup>/Nd<sup>144</sup> ratios are from 0.512895 to 0.512944 with high εNd (5.78~6.30), all these characteristics indicate that the basalts were likely generated from partial melting of the depleted mantle wedge without remarkable crustal and sediment influence. So we suggest that Bima formation volcanic rocks are not from the northward subduction of Neo-Tethy along the southern margin of Gangdese belt but products of an intra-oceanic subduction system.

[1] Yao P et al., 2006, *Acta Petrologica Sinica*, 22(3): 612-620

[2] Zhu DC et al., 2009, *Journal of Asian Earth Sciences*, 34: 298-309

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