Abstract: Magnetic signature of serpentinized mantle peridotite has crucial importance in understanding the serpentinization process and interpreting the origin of strong magnetization anomalies at ultramafic-hosted hydrothermal settings. However, different groups of serpentinized peridotites from both ocean drillings and ophiolite complexes have shown considerable variations in the abundance of magnetite (Oufi et al., 2002; Bonnemains et al., 2016; Li et al., 2017). We examined the magnetic properties, petrography and mineral chemistry of variably serpentinized peridotites from the Zedang ophiolite in the eastern Yarlung-Zangbo suture in south Tibet to evaluate the conditions of serpentinization and magnetite formation as well as magnetic sources in suture zones.

The studied samples were 0–90% serpentinized with densities from 3.316 to 2.593 g cm$^{-3}$ and show typical mesh textures of olivine replaced by serpentine on thin sections of core specimen. Serpentines were divided into type-1 Fe-poor serpentine mesh (1.84–2.88 wt% FeO) associated with magnetite in the early stage and type-2 Fe-rich serpentinite cores (3.92–5.12 wt% FeO) with no formation of magnetite in the late serpentinization. Brucite vein appeared in central serpentine veins and show Mg/\((\text{Mg}+\text{Fe})\) values of 0.74–0.87 at ~50–70% of serpentinization. Pure magnetite was identified as the main magnetic carrier by thermomagnetic analyses, but minor Cr-magnetite (~0.8 mole fractions of FeO) was also detected due to oxidation of early spinel.

All the peridotite samples show a rapid increase of magnetic susceptibility from ~0.001 to ~0.03 SI before 40–50% of serpentinization and a following flat trend in values 0.02–0.03 SI at ~ 50% of serpentinization. This density–susceptibility relationship differs from the rapid production of magnetite above 60–70% of serpentinization for many abyssal peridotites (Oufi et al., 2002; Bach et al., 2006) and suggests that magnetite formation was coupled with hydration of olivine in the early serpentinization but the two decoupled at ~ 40–50% of serpentinization. This transition is consistent with the petrographic observation that magnetite-free serpentinization was developed in higher degrees (> 50%) of serpentinization.

Prior studies suggested that serpentinization of < 200°C would generate Fe-rich brucite, serpentine and little magnetite, whereas magnetite-rich serpentinization was associated with Fe-poor brucite and occurred at higher temperatures of 200–300°C (Klein et al., 2014). The petromagnetic features of serpentinized peridotites from the Zedang ophiolite indicate that the serpentinization process took place initially above 250°C (estimate from brucite composition) and continued to lower temperatures of < 200°C, probably during the mantle lithosphere cooling down in forearc settings (Xiong et al., 2017). These serpentinized peridotites have higher magnetization intensities (average 2.26 Am$^{-1}$) than mafic dolerite dykes and basaltic volcanic rocks (mostly < 1 Am$^{-1}$) and should be significant sources of aeromagnetic highs in the Yarlung-Zangbo suture.

Key words: serpentinization, rock magnetism, Zedang ophiolite, Yarlung-Zangbo suture

Acknowledgments: This work is granted by the Fundamental Research Funds for the Central Universities (Grant No. CUG180620) and the NSFC project (Grant No. 41520104003).

References


About the first and corresponding author

LI Zhiyong, male, born in 1986 in Xuchang City, Henan Province; doctor; associate research of Institute of Geophysics and Geomatics, China University of Geosciences (Wuhan). He is now interested in the study on serpentinization and ophiolite magnetism. Email: zhiyonli@cug.edu.cn; phone: 027-67883251, 13006352055.