1. INTRODUCTION

The Qinglongshan oxygen and hydrogen isotope anomaly records an ancient hydrothermal system subducted into the upper mantle during Triassic continental collision, metamorphosed under coesite–eclogite facies conditions, and exhumed to Earth’s surface (Yui et al., 1995; Zheng et al., 1996, 1998; Rumble and Yui, 1998). The anomaly is defined by δ18O values as low as −7.7‰ for quartz and −10.1, −10.7, and −14.6‰ for coexisting garnet, omphacite, and rutile, respectively (Zheng et al., 1996; Rumble and Yui, 1998; Table 1). Phengites are depleted in both 18O/16O and D/H with δ18O and δD values of −5.7 and −127‰, respectively (Rumble and Yui, 1998; Table 2). It may be seen that all of the minerals in the ultrahigh pressure (UHP) metamorphic assemblage are depleted in 18O/16O and D/H and show an approach to equilibrium intermineral fractionation (Yui et al., 1995; Zheng et al., 1996, 1998; Rumble and Yui, 1998). The isotopic relationships were interpreted as indicating a presubduction, pre-UHP metamorphic age for acquisition of the depleted isotopic signature. The low 18O and δD values of the anomaly have attracted attention from researchers not only because they afford a baseline by which to measure crust–mantle interactions during subduction, but also because they may offer proof of the existence of an ancient cold climate.

It has been proposed that the granitic rocks of Hushan and Fangshan outcropping within the Qinglongshan area provided the heat necessary to heat groundwater, drive convection, and promote isotopic exchange between meteoric water and rocks (Rumble and Yui, 1998). Dating the granites provides a test of the proposal. A finding of granite ages younger than protolith ages of wall rocks but older than the age of UHP metamorphism would support the hypothesis. We report new analyses for 18O/16O and U-Pb in zircons from metamorphosed granites indicating a late Proterozoic age for the hydrothermal system, consistent with the hypothesis of granite-powered groundwater convection.

2. GEOLOGY

The Qinglongshan hydrothermal system outcrops over a known area measuring 50 by 50 km (Rumble and Yui, 1998). Qinglongshan is part of a larger hydrothermal system that includes a 50-km outcrop area in Dabieshan (Fig. 1), the rocks of which are also depleted in 18O/16O (Baker et al., 1997; Fu et al., 1999; Zheng et al., 1999). The two areas are now separated by 500 km of left-lateral, strike-slip displacement on the post-Triassic Tanlu Fault (Fig. 1; Rumble, 1998). The hydrothermal system thus has a minimum length scale of 100 km. Qinglongshan shows the characteristic features of unmetamorphosed hydrothermal systems, including unusually low δ18O and δD values (Yui, 1998; Table 2) combined with strong local heterogeneity (Taylor, 1971). Both the Qinglongshan and Dabieshan systems are preserved within coesite–eclogite facies rocks of the Dabie-Sulu orogenic belt formed during Triassic collision and subduction of the South China block beneath North China (Fig. 1). Triassic metamorphic conditions at Qinglongshan are estimated at 700 to 890°C and pressure greater than 28 kbar (Zhang et al., 1995).

3. PREVIOUS AGE DETERMINATIONS

Published geochronology on Qinglongshan rocks demonstrates the age of coesite–eclogite metamorphism to be Triassic—for example, 226 (Sm-Nd isochron), 219 (Rb-Sr isochron; Li et al. 1994; Li, 1996), and 217 Ma (U-Pb, lower discordia intercept; Ames et al., 1996). The evidence of oxygen isotope intermineral equilibration under high temperature conditions supports a premetamorphic age for acquisition of the low δ18O