The Shaliuhe terrane lies in the eastern segment of the North Qaidam UHP belt, NW China. Coesite inclusions were found in both rock-forming minerals and zircons indicate that it experienced UHP metamorphism (Zhang G et al., 2008, 2009; Zhang J et al., 2009, 2010). The discovery of UHPM oceanic lithostratigraphic section and rodingite (Zhang G et al., 2008, 2011) suggest an oceanic subduction at 445±7 Ma. Zhang J et al. (2009; 2010) also reported a 430~446 Ma metamorphic age and 840 Ma protolith age for a coesite-bearing eclogite in Shaliuhe area. Recently, Yu et al. (2013) yielded almost the same metamorphic age of ~440 Ma for both Shaliuhe eclogite and its host rock. What is going on around 440 Ma for Shaliuhe terrane? The oceanic deep subduction or the continental deep subduction? In this paper, combined studies of P-T evolution and zircon U-Pb dating were carried out for felsic gneiss and hosted eclogite in the Shaliuhe terrane, which can provide good constraint on deep subducted slab.

The studied felsic gneiss mainly consists of garnet (10 vol%), kyanite (8 vol%), plagioclase (4 vol%), phengite (2 vol%), biotite (5 vol%), quartz (70 vol%) and a small amount of rutile, apatite, K-feldspar, clinozoisite, epidote. Garnet occurs as enhedral coarse porphyroblasts with grain size ranging from 1.0 to 3.0 mm in diameter without inclusions. Phengite occurs as two textural types: Phengite I occurs as enhedral porphyroblasts, sizing about 1.0~1.5 mm; Phengite II occurs as aggregates around the kyanite or in the matrix. Garnet occurs as porphyroblasts range in size from 150 to 600 μm and surrounded by a retrograde corona of margarite, phengite, biotite and plagioclase. K-feldspar occurs as inclusions in epidote with a retrograde corona of plagioclase and clinozoisite. Epidote occurs as anhedral grains in the matrix. Garnet occurs mainly almandine, and all grains show obvious core-mantle-rim compositional zonation. In which, the Xgrs is almost constant (0.22~0.24) in the core and rapidly increases to 0.28~0.30 in the mantle and then slightly decreases to 0.27 in the rim. The Xpyr fluctuates between 0.13~0.15 in the core and mantle and then slowly increases to the 0.19 in the rim. The Xspe is 0.07~0.09 in the core and decreases rapidly to 0.01~0.02 in the mantle and decreases to <0.01 in the rim. The Xalm is almost unchanged (0.53~0.58) from the core to the rim. This chemical zonation suggests three stage growth of the garnet. In which, the Grt was formed at the prograde metamorphic stage, the Grtm at the peak stage and the Grt at the retrograde stage. Si content is higher in Phengite I (vary from 3.35~3.42 p.f.u) and obviously lower (3.15~3.20) in phengite II. Plagioclase is characterized by the high content of albite (>75 mol%), may resulted from the breakdown of jadeite during exhumation.

Combined petrography, mineral chemistry study, Grt-Phen Fe2+-Mg exchange geothermometer (Wu C M et al., 2006), Ti-in-zircon thermometer (Watson et al., 2006; Ferriss et al., 2008) and Grt-Phen-Ky-Coe geobarometer (Krough Ravna et al., 2004) with Thermocalc P-T pseudosection calculation, four main metamorphic stages are recognized: (1) a prepeak stage record by the Grt composition maybe at about P=1.48~2.05 GPa, T=600~700 °C; (2) an UHP stage with the assemblage of Grt+PhenI+Ky+Ru±Jd±Coe at P=3.15~3.29 GPa and T=830~850 °C; (3) a HT stage with the assemblage of Grt+Ky+Kfs+Ru+Qtz±Jd±Coe at P=2.2~2.4 GPa, T=900~950 °C; and (4) a retrograde stage with the assemblage of PhenI±Grt±Bt +Pl+Mrg+Co +Ep+Ru at P=1.0~1.15 GPa, T=600~650 °C, they formed a clockwise PT path from prograde to peak and then to retrograde metamorphism. This P-T path is the same as the hosted
eclogite (Song et al., 2003), indicating that the Shaliuhe eclogite and its country rock experienced the same subduction and exhumation event.

CL images reveal that zircons from felsic gneiss are round or prismatic, most grains are characterized by a large dark taxitic core surrounded by a narrow bright structureless rim, tiny residual zircon could be observed in a few cores. Because they are less than 30 µm of analyzed spots or are too thin to be sufficient acquired, no data was obtained from the residual cores and the rims. All analyzed zircons have low content of Th (<0.1 ppm) and high content of U (82–1842, av=548.7 ppm) and low Th/U ratios (<0.1), typical for the metamorphic characters. The obtained 448.6±2.5 Ma (MSWD=0.16), which is consistent with the metamorphic age of garnet bearing mica-schist reported by Yu et al., (2013). The difference in REE pattern may resulted from the low content of garnet in mineral assemblage.

Zircons from eclogite are subhedral-anhedral short prism or rounded granular crystals, ranging from 50–120 µm in diameter. Most of them are homogeneous with light luminescence. All of the 25 analyzed spots have low content of Th (<5 ppm), U (<300, av=68 ppm) and very low Th/U ratios (0.003–0.083), fall in the metamorphic zircon Th/U ratio field. They display LREE depletion and flat or negative slope HREE patterns without Eu anomalies and vary Yb/Gd ratios from 0.3 to 19.9 (2.5 in average), all these suggest an eclogite-facies genesis. All analyzed spots formed a cluster near the Tera-Wasserburg concordia line and give a weighted mean age of 443.9±2.5 Ma (MSWD=0.67), which is consistent with the eclogite UHPM age of other studies (Zhang G et al., 2008, 2011; Zhang J et al., 2009, 2010; Yu et al., 2013).

The obtained 448.6±2.5 Ma metamorphic age of the Shaliuhe felsic gneiss are identical within error with the 443.9±2.5 Ma age of the hosted eclogite, together with their same clockwise P-T path from prograde to peak UHP metamorphism and followed by a high-pressure granulite facies overprint and a (garnet) amphibolite facies retrograde metamorphism, indicating that the Shaliuhe eclogite underwent UHP metamorphism during early Paleozoic in situ with its host felsic gneiss. This provides strong evidence for continental deep subduction of the Shaliuhe terrane at about 443–448 Ma.

**Key Words:** Continental deep subduction, Zircon U-Pb dating, P-T Path, eclogite and its host gneiss, the North Qaidam

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**References**


Fig. 1 Micrographs showing typical textures in felsic gneiss
(a) Garnet, phengite, and kyanite occur as porphyroblasts and phengite I and kyanite is surrounded by plagioclase. (b) The plagioclase corona of phengite I (BSE image). (c) The corona of margarite, phengite II biotite and plagioclase of kyanite (BSE image, the prism is 100 μm). (d) The plagioclase and clinzoisite corona of K-feldspar (BSE image, the prism is 100 μm).

Fig. 2 Backscattered-electron image and rim-to-rim major-element compositional profiles of representative garnet porphyroblast along A-A’
Fig. 4 CL image, chondrite normalized REE pattern and zircon U-Pb dating for eclogite and felsic gneiss

(a, b) CL image of eclogite (a) and felsic gneiss (b) zircons, labeled with the laser analysis spots and their $^{206}\text{Pb}/^{238}\text{U}$ age. (c, d) Chondrite normalized REE pattern of eclogite (c) and felsic gneiss (d) zircons. (e) TW diagram and weighted mean age diagram of eclogite; (f) Concordia diagram and weighted mean age diagram of felsic gneiss.