**Research Advances**

# Zircon U-Pb Chronology and Whole-rock Sr-Nd Isotope Compositions of Granite Porphyry in the Kaladaban Area of the Northern Altyn

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## Objective

The Altyn Tagh marks the northern margin of the Qinghai-Tibet Plateau and lies between the Tarim block to the north and the Qaidam block, Qilian Orogen, and Kunlun orogenic belt to the south. The Altyn Tagh region contains ophiolite, high- to ultrahigh-pressure metamorphic rocks, and igneous rocks. Previous research has virified the occurrence of continental rifting, subduction, slab roll-back, and collision between the Tarim block and Proto-Tethys oceanic plate. Moreover, Kaladaban volcanic rocks are mainly distributed in the north Altyn region. Studies of the magmatic evolution of this region have proposed that Altyn oceanic plate was subducted during the Ordovician (Han et al., 2012; Wang et al., 2017). However, the specific timing and other aspects of the subduction are debated, and an investigation of granite porphyry in the Kaladaban area would improve our understanding of this subduction event. In this study, we present new U-Pb zircon dating result and Sr-Nd isotope composition data for granite porphyry from the North Altyn region. The objective is to constrain the timing of subduction of the North Altyn oceanic plate and establish the petrogenesis and magma source of the granite porphyry.

## Methods

Zircon laser ablation-inductively coupled plasma–mass spectrometry (LA-ICP-MS) U-Pb dating was performed using a New Wave UP 213 UV La system and a Finnigan Neptune type multi-collector ICP-MS at the Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing. Age calculations and concordia plots were made using Isoplot (ver. 3.0) (Ludwig, 2003).

Samples for Sr-Nd isotope analysis were analyzed using a multi-collector MS instrument (ISOPROBE-T) at analytical laboratory of the Beijing Research Institute of Uranium Geology, Beijing, China. $^{143}Nd/^{144}Nd$ ratios were corrected for mass fractionation by normalization to $^{146}Nd/^{144}Nd=0.7219$, and $^{87}Sr/^{86}Sr$ ratios were normalized to $^{86}Sr/^{88}Sr = 0.1194$. During the period of data acquisition, analyses of the La Jolla and BCR-1 Nd standards yielded $^{143}Nd/^{144}Nd=0.511853\pm7$ ($2\sigma$) and $0.512604\pm7$ ($2\sigma$), respectively, and of the NBS-607 Sr standard yielded $^{87}Sr/^{86}Sr =1.20042 \pm 2$ ($2\sigma$).

## Results

Seventeen zircon spots were analyzed for sample KLB-85, yielding concordant $^{206}Pb/^{238}U$ ages ranging from 523 to 501 Ma with a weighted mean age of 515 ± 3.6 Ma (n = 17, MSWD = 0.26) (Appendix 1). The age of 515 Ma represents the time of zircon crystallization in the granite porphyry. Therefore, these felsic volcanic rocks were formed by the intrusion of acidic magma during the early Paleozoic.

The whole-rock initial $^{87}Sr/^{86}Sr$ ratios and $\varepsilon_{Nd}(t)$ values werecalculated at t = 515 Ma on the basis of the zircon U-Pb age obtained in this study (Fig. 1). The initial $^{87}Sr/^{86}Sr$ ratios for the granite porphyry vary from 0.71048 to 0.75332 with $^{143}Nd/^{144}Nd$ ratios ranging from 0.51165 and 0.51186 (Appendix 2). The granite has $(^{87}Sr/^{86}Sr)_i$ values of 0.70669 to 0.70884, $\varepsilon_{Nd}(t)$ values of −6.5 to −2.3, and $T_{DM}$ values of 1.06 to 1.57 Ga(Fig. 2) .

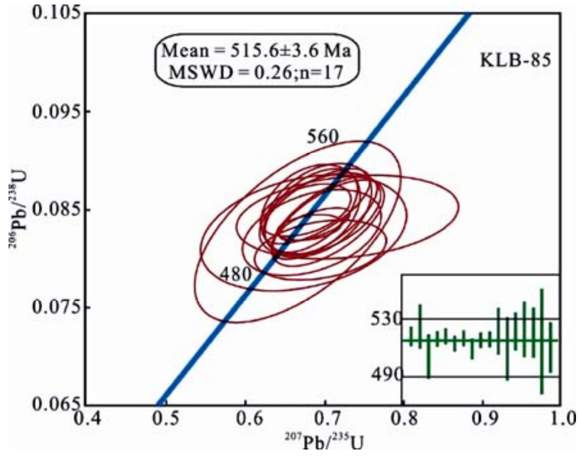


Fig. 1. Zircon U-Pb concordia diagram for the granite porphyry in the northern Altyn region.

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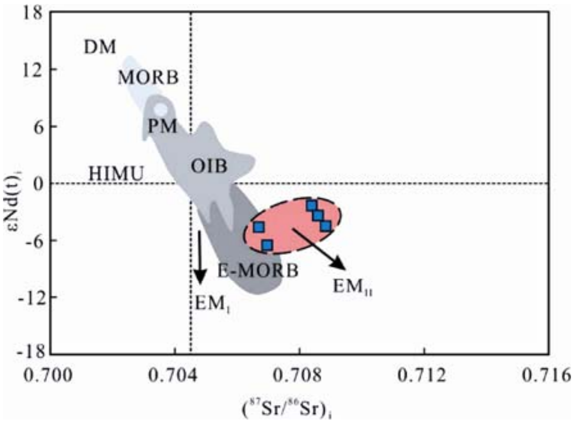


Fig. 2. ($^{87}$Sr/$^{86}$Sr)$_i$ versus. $\varepsilon_{Nd}(t)$ diagram for the granite porphyry.
EMI and EMII-enriched mantle I and II sources, respectively; HIMU-high-l mantle source; DM-depleted mantle source; PM-primitive mantle; MORB-mid-ocean ridge basalt; OIB-oceanic island basalt.

## Conclusions

The new LA-ICP-MS zircon U-Pb age indicates that the north Altyn oceanic plate was subducted prior to 515 Ma. The negative $\varepsilon_{Nd}(t)$ values (–6.5 to –2.3) and corresponding two-stage model ages of 1.05 to 1.56 Ga, indicated that the magma source of the granite porphyry was derived mainly from partial melting of Mesoproterozoic lower crust. The continental margin of the northern Altyn region is inferred to have changed from a passive margin to an active margin during the early Paleozoic, forming a trench-island arc (volcanic arc)-oceanic basin tectonic system. Large-scale subduction-related magmatism developed in the northern Altyn region from the early Cambrian.

## Acknowledgments

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**Appendix 1 LA-ICP-MS zircon U-Pb dating data for granitic porphyry from northern Altyn Tagh region**

| Analysis spot | Th | U | Th/U | $^{207}$Pb/$^{206}$Pb | $^{207}$Pb/$^{235}$U | $^{206}$Pb/$^{238}$U | $^{208}$Pb/$^{232}$Th |
|---|---|---|---|---|---|---|---|
| | ppm | ppm | | Age (Ma) | Age (Ma) | Age (Ma) | Age (Ma) |
| KLB-85-1 | 124.72 | 253.08 | 0.49 | 609.28 | 534.38 | 517.98 | 456.37 |
| KLB-85-2 | 418.21 | 571.06 | 0.73 | 605.58 | 537.69 | 524.86 | 381.22 |
| KLB-85-3 | 111.66 | 259.66 | 0.43 | 698.16 | 536.09 | 501.17 | 480.24 |
| KLB-85-4 | 421.57 | 699.22 | 0.60 | 633.35 | 536.06 | 515.99 | 455.55 |
| KLB-85-5 | 425.09 | 653.81 | 0.65 | 650.02 | 541.82 | 518.21 | 430.51 |
| KLB-85-6 | 594.27 | 887.66 | 0.67 | 550.04 | 518.30 | 513.01 | 452.27 |
| KLB-85-7 | 534.53 | 622.25 | 0.86 | 609.28 | 531.74 | 516.09 | 447.48 |
| KLB-85-8 | 303.52 | 460.71 | 0.66 | 720.38 | 548.46 | 508.88 | 455.70 |
| KLB-85-9 | 345.00 | 552.61 | 0.62 | 561.15 | 521.96 | 515.92 | 444.67 |
| KLB-85-10 | 789.64 | 1001.44 | 0.79 | 605.58 | 533.57 | 516.61 | 421.96 |
| KLB-85-11 | 1273.49 | 1307.05 | 0.97 | 733.34 | 555.56 | 521.56 | 391.80 |
| KLB-85-12 | 833.31 | 1171.94 | 0.71 | 566.70 | 523.74 | 509.53 | 421.68 |
| KLB-85-13 | 275.10 | 421.60 | 0.65 | 561.15 | 524.44 | 521.39 | 401.96 |
| KLB-85-14 | 833.59 | 1300.59 | 0.64 | 620.39 | 536.10 | 522.63 | 394.00 |
| KLB-85-15 | 728.04 | 895.91 | 0.81 | 638.91 | 540.39 | 520.52 | 461.24 |
| KLB-85-16 | 439.71 | 602.57 | 0.73 | 564.85 | 517.51 | 514.30 | 471.25 |
| KLB-85-17 | 276.53 | 417.45 | 0.66 | 633.35 | 530.21 | 510.62 | 451.92 |

**Appendix 2 Rb-Sr and Sm-Nd isotopic compositions for the granitic porphyry in northern Altyn region**

| Sample no. | T(Ma) | $^{87}$Rb/$^{86}$Sr | $^{87}$Sr/$^{86}$Sr | ($^{87}$Sr/$^{86}$Sr)$_i$ | $^{147}$Sm/$^{144}$Nd | $^{143}$Nd/$^{144}$Nd | ($^{143}$Nd/$^{144}$Nd)i | $\varepsilon_{Nd}$(t) | $T_{DM}$(Ga) |
|---|---|---|---|---|---|---|---|---|---|
| KLB-85 | 515 | 5.4713 | 0.74852 | 0.70836 | 0.18689 | 0.51243 | 0.51180 | -3.42 | 1.05 |
| KLB-86 | 515 | 0.7045 | 0.71210 | 0.70693 | 0.19869 | 0.51231 | 0.51164 | -6.54 | 1.37 |
| KLB-87 | 515 | 6.3901 | 0.75332 | 0.70642 | 0.11390 | 0.51213 | 0.51175 | -4.47 | 1.55 |
| KLB-88 | 515 | 5.7897 | 0.75109 | 0.70859 | 0.11545 | 0.51214 | 0.51175 | -4.37 | 1.56 |
| KLB-89 | 515 | 0.2863 | 0.71048 | 0.70838 | 0.10483 | 0.51221 | 0.51186 | -2.31 | 1.31 |