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SHRIMP zircon age of the high aeromagnetic anomaly zone in central Tarim Basin and its geological implications

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ABSTRACT

In order to get the correct isotopic age, SHRIMP U-Pb zircon date of Precambrian hornblende granite in Well TD2, located in the central aeromagnetic belt in the eastern of the Tarim basin, was carried out. The result showed a dependable age of 1908.2 ± 8.6 Ma, which demonstrated that the granite pluton is the result of the magmatic activity in early Palaeoproterozoic. It is indicated that the central aeromagnetic belt across Tarim basin, divided it into north and south block, is formed before Neoproterozoic by a large scale tectonothermal events based on the seismic and drilling date. The Tarim continent may have different age and type basements formed the united crystalline basement in Precambrian. This result has yielded new intraplate evidence to constrain the relation between the Tarim plate and the Colombia supercontinent.

Keywords: Tarim Plate; Precambrian; Basement; SHRIMP U-Pb Zircon Dating; Supercontinent

1. INTRODUCTION

Tarim basin, located at northwest of china, is an ancient craton basin that has an uniform crystalline basement [1]. There exsits obviously high magnetic anomaly zones extending in EW for over 500 km at the basement of Tarim basin (**Figure 1**). The high magnetic anomaly zones devided the basin into south and north blocks which have different basement structures from each other. Above the basement, the huge thick strata had deposited from Nanhua period to Quaternary but only well TD2 had drilled Precambrian formations. Due to deficiency of intrabasinal chronology data and surrounding outrops data, the structure and forming age of the basement are not understood clearly [1-3]. Through zircon SHRIMP U-Pb dating of basement granites in well TD2, this article can provide constraints for deeply discussing the forming age and evolution of Precambrian basement of Tarim plate.

2. SAMPLE AND METHOD

2.1. Characteristics of Samples

TD2 well had drilled Precambrian basement formations in depth between 4996 to 5040 m and 0.97 meters long of core was acquired. The lithology is altered hornblende granite with light gray or light green-gray color. The rocks have granitic texture, vermicular structure and block structure. The mineral content of platy prismatic K-feldspar, hypautomorphic columnar albite, anhedral quartz, hornblende and pyrite are 49% - 54%, 5% - 30%, 1% - 20%, 10% - 20% and <1%. The hornblendes (only remains can be seen) are columnar and granular which metasomatized by byssolite and chlorite. Fine-grained pyrite can also be seen in hormblendes. Quartz (wavy extinction) and feldspar usually generate cracks resulting from structural compression.

2.2. Sample Preparation and Analysis

This article choose cores of Precambrian granite in well TD2 to analyse. Samples were prepared using facilities

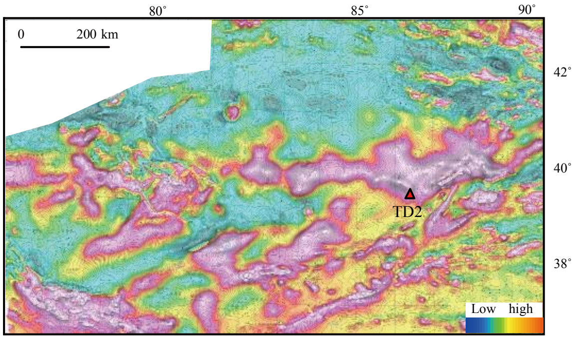

Figure 1. The aeromagnetic ΔT contour diagram and sampling place in Tarim basin.

at the Department of Hebei Geological Survey in Langfang city, China. Rock samples were first disaggregated in a jaw crusher and powdered. The zircons were then separated using standard elutriation, heavy-liquid and magnetic mineral separation techniques. Zircons with different crystal shape and color were picked up through bioscopes to make zircon target. The zircon grains were then imaged by visible light and scanning electron microscope equipped with cathodoluminescence (CL) at Institute of Mineral Resources, Chinese Academy of Geological Sciences. The isotopic U-Pb-Th analyses were obtained using the SHRIMP II at Beijing Shrimp Center and the Pb, U and Th concentrations were referenced to the standard zircon TEMORA (417 Ma). The undetermined and standard zircons were first fixed together at epoxy target, then polished, washed and plated gold to measure. Cracks and inclusions would be avoid while measuring. Statistical treatment and plotting of concordia diagrams were achieved using the Squid 1.0 and Isoplot/Ex program of Ludwig (2001). The value of common Pb in zircons were normalized to the measured ^{208}Pb. Individual corrected ratios and ages are reported with 1σ analytical errors. The weighted mean ^{206}Pb/^{238}U ages are presented at 95% confidence levels.

Most of select zircon particles with uniform size are colorless transparent euhedral crystals. Individual zircon crystals which have developed cylindrical and conical surface are columnar euhedral and on average 100 - 200 μm in length and 1:1 - 3:1 in aspect ratio. Some zircon crystals contain cracks and cores. Most of zircons that have obviously zonal structures were all magmatic crystallization (**Figure 2**).

3. RESULTS AND DISCUSSION

3.1. Ages of Rocks

By analyzing U-Pb isotopic age of 16 measuring points from well TD2 samples (**Figure 3**, **Table 1**), the zircons had the average content of U and Th of 163 - 597 × 10^{-6} and 34 - 495 × 10^{-6}. The value of Th/U between 0.06 to 2.07 indicates that the zircons may be influenced by metamorphism.

Zircon-SHRIMP dating demonstrates that the apparent age of ^{206}Pb/^{238}U is concentrated between 1755.3 - 1942.4 Ma, with average age of 1845.7 Ma. In ^{207}Pb/^{235}U - ^{206}Pb/^{238}U diagram, 16 measuring dates are crowded together on or near concordia and obtain an concordant age of 7908.2. ± 8.6 Ma (MSWD = 1.2), which may represent the crystallization age of granites.

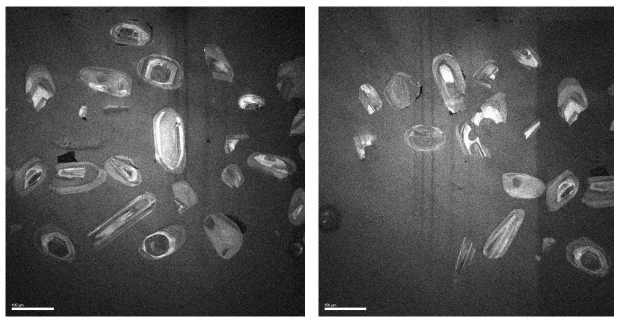

Figure 2. Some of the CL images of zircon in well TD2，Tarim Basin.

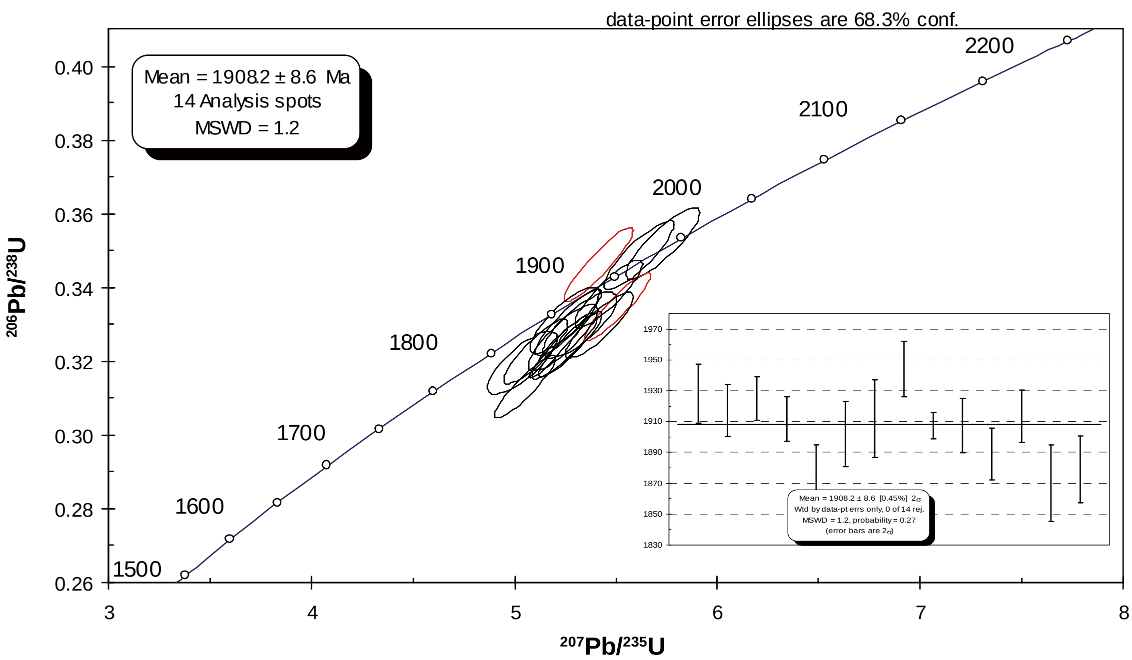

Figure 3. Zircon ^{207}Pb/^{238}U - ^{206}Pb/^{238}U concordia diagram of granodiorite from Well TD2.

Table 1. The SHRIMP U-Pb isotopic data for the zircons in granodiorite from Well TD2, Tarim Basin.

Spot name	Comm. ^{206}Pb/%	U/×10^{-6}	Th/×10^{-6}	$^{232}Th/^{238}U$	Rad ^{206}Pb/×10^{-6}	$^{207}Pb/^{235}U$	err/%	$^{206}Pb/^{238}U$	err/%	$^{206}Pb/^{238}U$ Age (Ma)		$^{207}Pb/^{206}Pb$ Age (Ma)		Err/%
1.1	0.45	248	495	2.07	75.1	5.73	2.1	0.3516	1.8	1942.4	±30.1	1928	±19.0	2.1
2.1	0.19	201	97	0.50	56.0	5.25	2.0	0.3240	1.8	1809.3	±28.6	1917	±16.9	2.3
3.1	0.18	205	257	1.30	58.9	5.51	2.0	0.3346	1.8	1860.5	±29.2	1947	±13.1	1.9
4.1	0.45	243	330	1.40	68.0	5.27	1.9	0.3243	1.8	1810.5	±28.1	1925	±14.0	2.0
5.1	0.33	203	141	0.72	54.7	5.05	1.9	0.3130	1.8	1755.3	±27.2	1911	±14.4	6.5
6.1	0.44	205	144	0.73	57.1	5.10	2.0	0.3224	1.8	1801.4	±27.8	1877	±17.7	2.2
7.1	0.50	179	92	0.53	50.4	5.23	2.1	0.3261	1.8	1819.5	±28.4	1902	±21.0	2.5
8.1	0.27	188	124	0.68	53.5	5.32	2.3	0.3297	1.8	1836.8	±28.4	1912	±25.2	2.3
9.1	0.34	189	122	0.67	53.8	5.42	2.0	0.3296	1.8	1836.4	±28.4	1944	±18.0	2.3
10.1	0.14	597	34	0.06	166.3	5.21	1.8	0.3237	1.7	1807.6	±26.8	1907	±8.5	6.1
11.1	0.49	251	109	0.45	75.1	5.41	2.1	0.3459	1.9	1915.0	±31.6	1855	±14.4	3.0
12.1	0.22	211	277	1.36	63.3	5.61	2.0	0.3486	1.8	1927.8	±29.6	1907	±17.6	2.5
13.1	0.31	163	113	0.72	46.5	5.26	2.0	0.3303	1.8	1839.8	±28.7	1889	±16.7	2.1
14.1	0.43	189	333	1.82	55.1	5.46	2.0	0.3380	1.8	1876.8	±29.2	1913	±16.8	2.7
15.1	2.00	272	146	0.55	76.1	5.02	2.2	0.3187	1.8	1783.2	±27.2	1869	±24.0	3.7
16.1	0.38	223	105	0.49	63.6	5.24	2.2	0.3309	1.8	1842.7	±28.6	1879	±21.5	3.5

3.2. Tectonic Implications

The Prenanhua period basement consists of early Neoproterozoic Aksu gr metamorphic rocks in north Tarim basin while early-middle Neoproterozoic granite in south Tarim basin [2,4,5], but well TD2 had drilled Paleoproterozoic granite. All of the above illustrates that ancient crystalline basement of Tarim basin consists of different basements in ages and types. Well TD2 crystalline basement underlying the Sinian dolomite, between which existed for more than 1 billion years hiatus which also has the obvious response in seismic profile (**Figure 4**). The large scale regional unconformity before deposition of Nanhua strata indicates that the uniform basement in Tarim plate had not generated until Prenanhua period.

The basement of Tarim basin develops high magnetic anomaly zones which lies along 39˚40′ northern latitude, with 10 - 80 km in width. Magnetic anomaly intensity is generally at 200 - 350 nT, with maximum at 500 nT [1]. Magnetic field reduced to the pole (Δta) upward to 20 km and 40 km still presented as broad high value anomaly indicates that magnetic sources are deep burial, large volume and strong magnetism. There exists various inferences about geological properties and formation ages of the magnetic sources [1,2]. Drilling results of well TD2 shows that high magnetic anomaly which may be response of granite rocks was the result of tectonic-thermal event in early Paleoproterozoic and had existed before the forming of Tarim uniform basement in Neoproterozoic.

The reconstruction of Tarim paleocontinent and its place in global supercontinent is a very complex question worth to be further discussed [6,7], while zircon ages inside Tarim basin can provide isotopic chronological evidence to further discuss the relationship between Tarim as well as its peripheral plates and supercontinent. Zircon-SHRIMP dating confirms the mantle magmatic activity in early Paleoproterozoic in Tarim basin and this tectonic event reflected by zircon ages indicates Tarim terrane maybe associated with Columbia Supercontinent. Altun and Kuluktag regions also have chronological data of this period [3,8,9]. Tarim plate may be part of the supercontinent, so the relationship between Tarim plate and Columbia Supercontinent needs to further study.

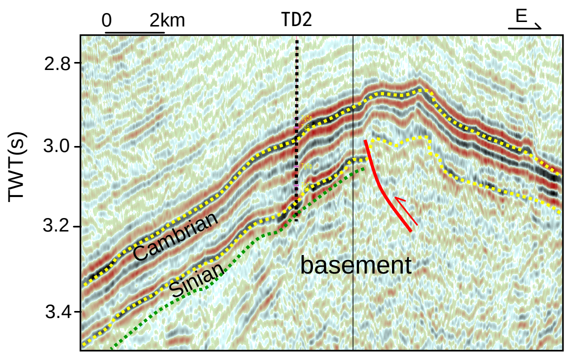

Figure 4. Seismic profile across well TD2.

4. CONCLUSIONS

Aeromagnetic anomaly zone in central of Tarim Basin may be the result of Paleoproterozoic tectonic-thermal event which maybe associated with Columbia Supercontinent event. Granite basement formed in early Paleoproterozoic inside Tarim Basin indicates that Prenanhua period basement of Tarim basin consists of different basements in ages and types.

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