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# Paleomagnetic Constraints on the Kinematic Process of Northern Qiantang Block in Tibetan Plateau

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**Abstract:** The Tibetan Plateau, sandwiched among the Tarim, North China, South China, and India blocks, is a collage of microcontinents rifted and drifted from the northern margin of Gondwanaland toward Eurasia from the Late Paleozoic period. As one of the crucial tectonic components in Tibetan Plateau, the kinematic process of the northern Qiangtang Block is still unclear. One of the main reasons is that the quantitative paleomagnetic dataset to determine the paleoposition is sparse. To add more available paleomagnetic data into dataset, in these years, we carried out systematic paleomagnetic work on the Paleozoic to Mesozoic strata of the northern Qiangtang Block (Table 1). We obtained the Early-Middle Silurian paleomagnetic dataset from northern Longmucuo-Shuanghu suture. The dataset, based on 49 limestone specimens (6 sites), passed the reversal test (C class) with 95% confidence level. The paleopole was calculated to be at 43.2°N, 352.8°E with $A_{95}$ = 5.7° (N = 6), and correspond to the paleolatitude of 25.1°S ± 8.7° for the reference site. In the following context, a common reference point located at 33.7°N, 86.9°E is used for all paleolatitude comparisons. For the Early Devonian Period, characteristic remanent magnetizations (ChRM) derived from 33 limestone specimens (5 sites) which were sampled from the Mayigangri area of the hinterland of Qiangtang. The dataset passed the reversal test which corresponds to the paleopole at 44.5 °N, 243.4°E with $A_{95}$ = 4.0° and paleolatitude of 9.0°S ± 4.0°. For the Permian, the dataset derived from 10 sites of Changshehu and Xueyuanhe formations that passed bake, fold and reversal tests. The paleopole and paleolatitude are at 31.7°N, 226.8°E with $A_{95}$ = 9.3°and 15.4°S ± 9.3°, correspondingly (Cheng et al., 2012a). For the Late Permian, the ChRM was obtained from the 253 volcanic samples (30 sites) of Nayixiong formation which were sampled from the Nuoribanabao area. The primary remanence was testified by the fold tests. The paleopole and paleolatitude located at 10.6°N, 189.4°E with $A_{95}$ = 4.0° (N = 30) and 12.1°S ± 4.0°. For the Triassic period, the datasets for the Early and Late Triassic Period were obtained from the eight sites (74 samples) and eight sites (62 samples), respectively. Both the Early and Late Triassic datasets passed the fold tests. The Paleopoles were calculated to be at 24.9°N, 216.5°E with $A_{95}$ = 8.2° (N = 8) for the Early Triassic dataset, and 80.4°N, 185.2°E with $A_{95}$ = 7.5° (N = 7) for the Late Triassic. These paleopoles correspond to the paleolatitudes of 14.3°S ± 8.2° and 31.8°N ± 7.5°, respectively. For the Middle-Late Jurassic, the datasets were based on the 342 sedimentary rocks samples (29 sites) of Yanshiping group at the Yanshiping and Shuangquanhe areas. The result indicates that the northern Qiangtang Block located at (20-24) °N during that period (Cheng et al., 2012b). Our data combined with previously published results, a three-stage northward drift process of the northern Qiangtang Block was reconstructed. 1) This block situated at the subtropical latitude zone of southern hemisphere from the Early-Middle Silurian to the Early Triassic period; 2) Afterwards/then, it rapidly drifted to the northern hemisphere

**Table 1 The paleomagnetic results from the northern Qiangtang Block during the Paleozoic to the Mesozoic**

| Sampling Location | GPS | | Age | Rock Units | Lithology | *N*/*n* | Paleopole | | | Test | Paleolat. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lati. | Long. | | | | | λp (°N) | □p (°E) | $A_{95}$ | | |
| *Longmucuo* | 34.7 | 80.5 | $S_{1-2}$ | Longmuco Fm. | Limestone | 6/49 | 43.2 | 352.8 | 5.7 | RT | -19.7 ± 5.7 |
| *Mayigangri* | 33.8 | 86.6 | $D_1$ | Pingshagou Fm. | Limestone | 5/33 | 44.5 | 243.4 | 4.0 | RT | -9.0 ± 4.0 |
| *Rejuechaka* | 33.7 | 86.9 | $C_2$ | Walongshan Fm. | Sediments | 2/18 | 31.8 | 225.7 | 2.9 | - | -13.9 ± 2.9 |
| *Rejuechaka* | 33.7 | 86.9 | P | Xueyuanhe Fm. Rejuechaka Fm. | Andesite Sediments | 10/83 | 33.1 | 230.4 | 6.7 | RT,FT,BT | -14.9 ± 8.2 |
| *Nuoribanabao* | 33.9 | 91.9 | $P_3$ | Nayixiong Fm. | Tuff Andesite | 30/253 | 10.6 | 9.4 | 4.0 | FT | -16.2 ± 4.0 |
| *Rejuechaka* | 33.7 | 86.9 | $T_1$ | Yingshuiquan Fm., Kanglu Fm. | Sediments | 8/74 | 24.9 | 216.5 | 8.2 | FT | -14.3 ± 8.2 |
| *Tuotuohe* | 34.1 | 92.4 | $T_3$ | Jiezha Gp. | Sediments | 8/62 | 80.4 | 185.2 | 7.5 | RT | 31.8 ± 7.5 |
| *shuangquan* | 33.8 | 86.5 | $J_2$ | Buqu Fm. | Limestone | 8/54 | 61.6 | 337.3 | 11.7 | FT | 20.8 ± 11.7 |
| *Yanshiping* | 33.6 | 92.1 | $J_{2-3}$ | Suowa Fm.<br>Buqu Fm. | Limestone | 11/102 | 80.0 | 295.2 | 5.8 | FT | 24.8 ± 5.8 |
| *Yanshiping* | 33.6 | 92.1 | $J_{2-3}$ | Yanshiping Gp. | LimestoneSandstone | 18/240 | 75.5 | 312.0 | 5.8 | FT | 23.0± 5.8 |

Notes: Rock units: the name of sampled strata; Gp., Group; Fm., Formation; n/N, sites/samples used to calculate the paleopole; $A_{95}$, the 95% confidence circle about the reference pole; Tests: RT, FT, CT, BT: positive fold test, reverse test, conglomerate test and bake tests, respectively; Plaleolat., the paleolatitudes calculated for the same reference site (33.7°N, 86.9°E).

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during the Triassic, and 3) finally/terminally converged into the main body of Eurasia in the Late Triassic. A total of ~4,500 km northward movement from the Early-Middle Silurian to Middle-Late Jurassic occurred. The drifting process of the Northern Qiangtang Block since the Early Permian led to the transformation of multiple Tethys.

**Key words:** northern Qiangtang Block, Tibetan Plateau, paleomagnetism, kinematic process, Tethys

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