Background of crustal movement of Chinese mainland

ZHU Wenyao, CHENG Zongyi, WANG Xiaoya & XIONG Yongqing

Shanghai Observatory, Chinese Academy of Sciences, Shanghai 200030, China

Abstract Based on GPS data during May 1995—March 1998 of 12 IGS stations located in the Chinese mainland and its surrounding areas, the horizontal displacement rates of these IGS stations have been determined. The result can be available to study the background of the crustal tectonic motion in the chinese mainland.

Keywords: **GPS survey, crustal movement of Chinese mainland, background.**

The Chinese mainland is located in the southeastern part of the Eurasian plate and surrounded by Pacific plate, India plate and northasian block. Due to its special tectonic characteristics, the interplate deformation and the interact between blocks as well as the interior tectonic phenomena are very complicated. It is in the region that the crustal motion is the strongest among the global continents. The crustal motion of China occurs in the background of the global crustal movement. The plate blocks surrounding China exert certainly an important influence on the formation and the variation of the tectonic deformation field and the stress field of the Chinese mainland. The measuring results of stress direction of the Chinese crust show that the stress field of Chinese mainland is strongly affected by the collision between the India plate and the Eurasian plate in Himalaya arc area. Therefore, the study of the Chinese mainland crustal movement is not away from the study of the crustal movement of the background field surrounding it. The monitoring for the moving parameters of crustal movement of the background of the Chinese mainland and for the interior large-scale deformation of the Chinese mainland is very significant not only in the research for present crustal movement of China, in the perfecting the survey and junction for the present global crustal movement, but also in research and checking-up the global crustal tectonic theory.

1 The background of crustal movement of Chinese mainland obtained from GPS technique

The development of GPS technique provides a guarantee for high precision and high resolving power surveying plate movement and regional crustal deformation. For this, we have collected GPS data of about three years (May 1995—June 1998) for several IGS sites surrounding the Chinese mainland, such as Bangalore of India, Kitab of Uzebek, Irkutsk of Russia, Tsukuba and Usuda of Japan, Taejon of South Korea and the Guam in the Pacific as well as for some IGS sites in China, such as Shanghai, Lhasa, Taipei, Wuhan, Xi'an, etc., so as to monitor seccessively their displacement rates for a long time. In deducing, the ITRF94 was taken as the terrestrial referense system, the GPS satellite precision ephemeris and the ERP (Earth rotation parameter) were from IGS, the soft-ware used was the GAMIT, and the coordinates and displacement rates of Shanghai which come from the combination solution of VLBI, SLR and GPS techiques were fixed. The derived results are shown in table 1 and fig. 1. In table 1, the 4th and 5th columns are the results from GPS, the 6th and 7th columns from the plate movement model NNR-NUVEL1A, and the last two columns are the moving velocities with respect tothe Eurasian plate.

Measurement precision of displacement rates (north and east components) for every site in table 1 is estimated as[1]

$$\sigma_v = \frac{\sigma_r}{T}\sqrt{\frac{12(n-1)}{n(n+1)}}, \tag{1}$$

where σ_r is the standard deviation of single solution of site coordinate components, and n is the number of single solution, and T is the time span of the whole observations (unit: year).

Based on the results listed in table 1, we can make some preliminary analyses and deductions as follows:

The horizontal movement rates for Bangalore, Kitab and Irkutsk located in the south, west and north of China respectively basically coincide with the ones derived from plate movement model

Table 1 The survey results of moving rates for some IGS sites in Chinese mainland and its surrounding areas

Name	Longitude	Latitude	North	East	North/mm • a^{-1}	East	North	East
Bangalore	77° 34′	13° 01′	37.3±0.6	40.0±1.2	40.1	39.0	40.1	18.2
Guam	144° 52′	13° 35′	5.6±0.4	-9.5±0.6	20.1	-69.8	21.5	-29.9
Irkutsk	104° 19′	52° 13′	-7.6±0.5	24.6±0.7	-9.8	22.8	2.2	1.8
Kitab	66° 53′	39° 08′	3.6±0.3	31.0±1.0	2.4	25.9	1.2	5.1
Lhasa	91° 06′	29° 36′	18.1±0.3	45.6±0.9	-6.6	25.1	24.7	20.5
Shanghai	121° 12′	31° 06′	-12.8	33.1	-13.3	22.3	0.5	10.8
Taejon	127° 16′	36° 12′	-14.6±0.2	28.9±0.6	-14.2	21.1	-0.4	7.8
Taipei	121° 38′	25° 02′	-9.6±0.3	36.4±0.8	-13.3	22.3	3.7	14.1
Tsukuba	140° 05′	36° 06′	-9.5±0.3	-3.6±0.8	-15.7	19.2	6.2	-22.8
Usuda	138° 29′	36° 12′	-8.0±0.2	0.1±0.5	-15.6	19.5	7.6	-19.4
Wuhan	114° 15′	30° 30′	-8.3±0.3	31.3±0.8	-12.4	22.9	4.1	8.4
Xi'an	109° 00′	34° 12′	-8.1±0.3	29.4±0.8	-11.8	23.2	3.7	6.2

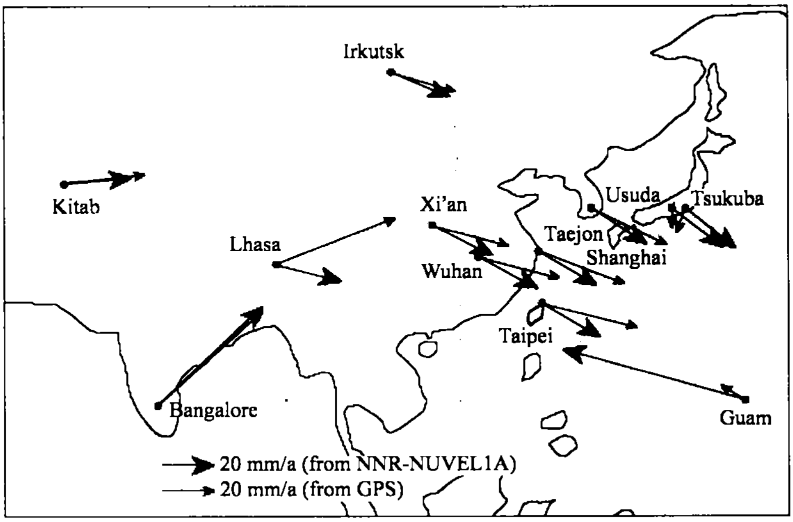

Fig. 1. The horizonal crustal motion velocity of IGS sites in Chinese mainland and its surrounding areas minitored by GPS and derived from NNR-NUVEL1A.

NUVEL1A which is based on geological and geophysical data. This seemly indicates that producing effects on the crustal movement of the Chinese mainland from the moving of India plate, European-northasian and Siberia blocks, which are represented by the three stations, have been stable for a long time (humdred million year scale).

There is an obvious northeastward movement for the Bangalore Station. This indicates that there is an intensive northeastward push-pressing action to the southwestern area of China for the eastern end of the India plate. Under this push-pressing action, there is a noticeable northward and eastward movement with respect to the Eurasian plate for the Lhasa site. On the contrary, the moving rate of northern Irkutsk is almost zero with respect to the Eurasian plate, and for the eastern sites of China, such as Shanghai, Wuhan, Xi'an, etc., their moving rate with respect to the Eurasian plate are also not large. This obviously shows that the push-pressing effect of the India plate on the Chinese mainland decreases gradually from south to north and from west to east, so it is certain that there is a fault zone between Lhasa and Irkutsk, and it is also certain that there is a south-north fault zone between the western part and the eastern part in China, what is more, these fault zones should possess the push-pressing feature. These conclusions have been proved in refs. [2, 3].

The difference between the moving rates derived by GPS and the estimated rates based on the geological movement model for Japanese Tsukuba and Usuda sites (assuming the two sites are located in the Eurasian plate in table 1 is very large. Obviously, the two sites are not located in the Eurasian plate, of course, they cannot belong to the Pacific plate (otherwise the difference will be greater). The present research indicates that the two sites may lie on the North American plate. Our surveying results indicate that in the global frame ITRF94, the movements of the two sites are neither like ones in the Eurasian plate for which there is eastward movement about 3 cm/a nor the Pacific plate for which there is a westward movement about 7 cm/a. Likely, here is a North American plate extension zone, its west side joins the Eurasian plate, its east side links up with the Pacific plate and its south side borders on the Philippine plate. The west side of Philippine plate links up with the Eurasian plate and its eastern end joins to the Pacific plate. In other words, because there is the extension zone of the North American plate located in Japan and the Philippine plate between the Pacific plate and the Eurasian plate, the Pacific plate dose not border on the Eurasian plate (see figs. 2 and 3)[4]. Therefore, the northwestward intensively push-pressing of the Pacific plate does not directly affect the crustal movement of the Chinese mainland, the indirect effect is not too great. The surveying northwestward moving rate of Guam located in the boundary line between the Pacific plate and the Philippine plate is much smaller than the moving rate of the Pacific plate. The relative movement between Taipei site, which is located near the boundary line between the Eurasian and the Philippine plate, and Shanghai site is quite small. On the contrary, the eastward movement rate of the Wuhan site located in the west of Shanghai site is smaller than Shanghai's. All of these indicate that the effect of the Pacific plate exerted on the Chinese mainland is not large.

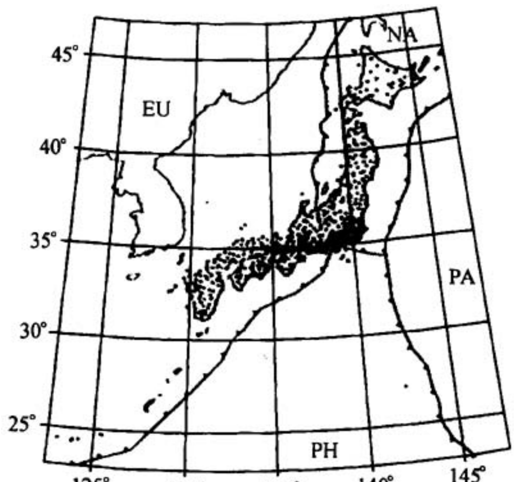

Fig. 2. The junction of Eurasian, North American, Pacific and Philippine plates.

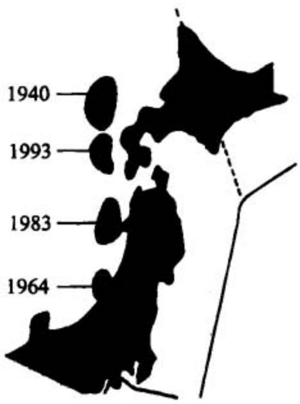

Fig. 3. The earthquake zone on the east side of the Sea of Japan .

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