

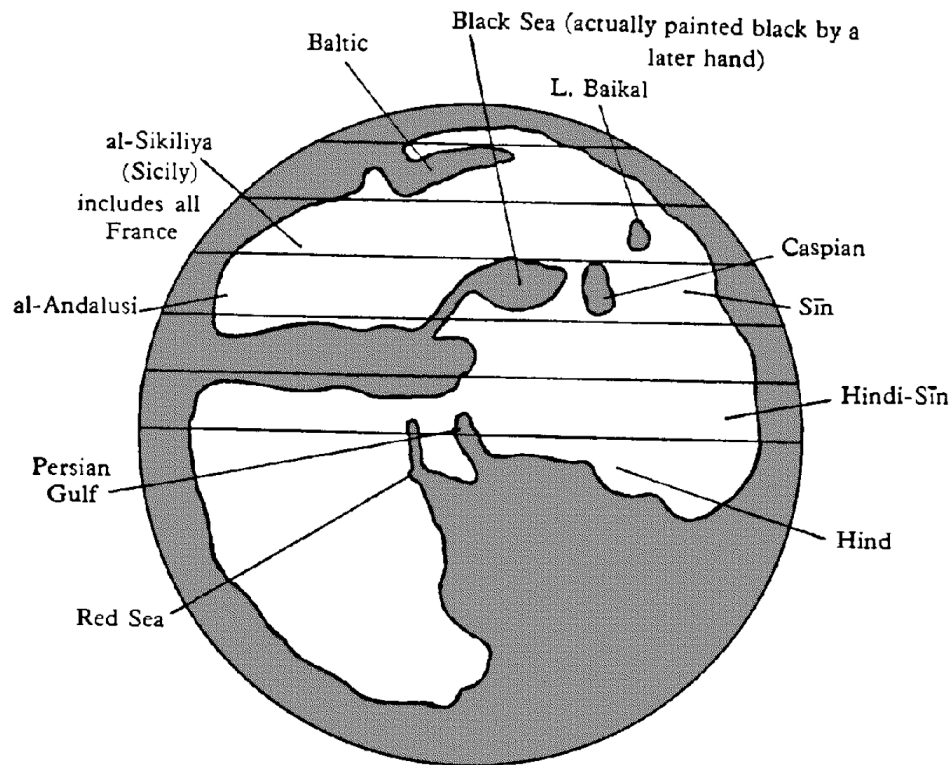
TITLE: *al-Tusi's World Map*

#229

DATE: 1331

AUTHOR: *Nasir al-Din al-Tusi/ Muhammad ibn Muhammad ibn al-Hasan al-Tusi.*

DESCRIPTION: This very simple map was published in *al-Tadhkirah al-Nasiriyah* [Memoranda on Astronomy] in the year 1331. This Arab interpretation shows a world map on a disc or sphere, with climates for the northern half only. Like the world map of Vesconte (via Sanudo) that it closely resembles (#228), it shows the tip of Africa pointing east and not south, but does not appreciate the peninsular character of India [*Hind*]. Like other Arab maps, al-Tusi's map demonstrates that the Arabs did participate in the tradition of religious cosmography, making their wheel-maps center on Mecca rather than on Jerusalem, Mt. Meru, or Mt. Khun-lun as was done in the cartography other civilizations (Europe, India, and China respectively). Actually, the Arab cartographers invoked a mythical city, *Arim* or *Arym*, which was supposed to be situated on the central meridian of the *oikoumene* [known world] some ten degrees east of Bagdad. In spite of this, Mecca was often placed orbo-centrally. The name *Arin* seems to derive from the Indian city of *Ujjain* in Malwa that had been one of the capitals of the fifth century A.D. Gupta kings and the site of a famous observatory. Ptolemy had known it as *Ozene*. Arabic geographers spoke of Arin as the cupola of the earth, a phrase that suggests connections with the central mountain of ancient Indian cosmology.



Although usually known as Nasir al-Din al-Tusi, his proper name was Muhammad ibn Muhammad ibn al-Hasan al-Tusi. In fact al-Tusi was known by a number of different names during his lifetime such as Muhaqqiq-i Tusi, Khwaja-yi Tusi and Khwaja Nasir.

Al-Tusi was born in Tus, which lies close to Meshed in northeastern Iran high up in the valley of the Kashaf River. He was born at the beginning of a century which would see conquests across the whole of the Islamic world from close to China in the east to Europe in the west. It was the era when the vast military power of the Mongols would sweep across the vast areas of the Islamic world displaying a bitter animosity towards Islam and cruelly massacring people. This was a period in which there would be little peace and tranquillity for great scholars to pursue their works, and al-Tusi was inevitably drawn into the conflict engulfing his country.

In 1214, when al-Tusi was 13 years old, Genghis Khan, who was the leader of the Mongols, turned away from his conquests in China and began his rapid advance towards the west. It would not be too long before al-Tusi would see the effects of these conquests on his own regions, but before that happened he was able to study more advanced topics. From Tus, al-Tusi went to Nishapur which is 75 km west of Tus. Nishapur was a good choice for al-Tusi to complete his education since it was an important center of learning. There al-Tusi studied philosophy, medicine and mathematics. In particular he was taught mathematics by Kamal al-Din ibn Yunus, who himself had been a pupil of Sharaf al-Din al-Tusi. While in Nishapur al-Tusi began to acquire a reputation as an outstanding scholar and became well known throughout the area.

The Mongol invasion reached the area of Tus around 1220 and there was much destruction. Genghis Khan turned his attention again towards the east leaving his generals and sons in the west to continue his conquests. There was, amid the frequent fighting in the region, peaceful havens which attracted al-Tusi. The Assassins, who practised an intellectual form of extremist Shi'ism, controlled the castle of Alamut in the Elburz Mountains, and other similar impregnable forts in the mountains. When invited by the Isma'ili ruler Nasir ad-Din 'Abd ar-Rahim to join the service of the Assassins, al-Tusi accepted and became a highly regarded member of the Isma'ili Court. Whether he would have been able to leave, had he wished to, is not entirely clear. However, al-Tusi did some of his best work while moving round the different strongholds, and during this period he wrote important works on logic, philosophy, mathematics and astronomy. The first of these works, *Akhlaq-i nasiri*, was written in 1232. It was a work on ethics which al-Tusi dedicated to the Isma'ili ruler Nasir ad-Din 'Abd ar-Rahim.

In 1256 al-Tusi was in the castle of Alamut when it was attacked by the forces of the Mongol leader Hulegu, a grandson of Genghis Khan, who was at that time set on extending Mongol power in Islamic areas. Some claim that al-Tusi betrayed the defences of Alamut to the invading Mongols. Certainly Hulegu's forces destroyed Alamut and, Hulegu being himself interested in science, he treated al-Tusi with great respect. It may be that indeed al-Tusi felt that he was being held in Alamut against his will, for certainly he seemed enthusiastic in joining the victorious Mongols who appointed him as their scientific advisor. He was also put in charge of religious affairs and was with the Mongol forces under Hulegu when they attacked Baghdad in 1258. Al-Tusi presented Hulegu with plans for the construction of a fine Observatory, Hulegu was happy to agree. Hulegu had made Maragheh his capital. Maragheh was in the Azerbaijan region of northwestern Iran, and it was at Maragheh that the Observatory was to be built. Construction of the Observatory began in 1259 west of Maragheh, and traces of it can still be seen there today. The observatory at Maragheh became operational in 1262. Interestingly the Persians were assisted by Chinese astronomers in the construction and operation of the observatory. It had various instruments such as a four meter wall quadrant made from copper and an azimuth quadrant which was the invention of Al-Tusi himself. Al-Tusi also designed other instruments for the Observatory which was far more than a center for astronomy. It possessed a fine library with books on a wide range of scientific topics, while work on science, mathematics and philosophy were vigorously pursued there.

Al-Tusi put his Observatory to good use, making very accurate tables of planetary movements. He published *Zij-i ilkhani* [the Ilkhanic Tables], written first in Persian and later translated into Arabic, after making observations for 12 years. This work contains tables for computing the positions of the planets, and it also contains a star catalogue. This was not the only important work which al-Tusi produced in astronomy. It is fair to say that al-Tusi made the most significant development of Ptolemy's model of the planetary system up to the development of the heliocentric model in the time of Copernicus. In al-Tusi's major astronomical treatise, *al-Tadhkira fi'ilm al-hay'a* [Memoir on astronomy] he:

... devised a new model of lunar motion, essentially different from Ptolemy's. Abolishing the eccentric and the center of prosneusis, he founded it exclusively on the principle of eight uniformly rotating spheres and thereby succeeded in representing the irregularities of lunar motion with the same exactness as the *Almagest*. His claim that the maximum difference in longitude between the two theories amounts to 10 proves perfectly true. In his model Nasir, for the first time in the history of astronomy, employed a theorem invented by himself which, 250 years later, occurred again in Copernicus, *De Revolutionibus*, III 4.

The theorem referred to in this quotation concerns the famous "Tusi-couple" which resolves linear motion into the sum of two circular motions. The aim of al-Tusi with this result was to remove all parts of Ptolemy's system that were not based on the principle of uniform circular motion. Many historians claim that the Tusi-couple result was used by Copernicus after he discovered it in Al-Tusi's work, but not all agree; see for example where it is claimed that Copernicus took the result from Proclus's *Commentary* on the first book of Euclid and not from al-Tusi.

The 13th century Persian astronomer Nasir al-Din al-Tusi, upended the geocentric Greek view of the universe, science historian Ahmed Djebbar explains, by declaring Ptolemy's model of planetary motion flawed and creating his own more accurate, but still Earth-centered, version. Three centuries later, the Polish astronomer Nicholas Copernicus borrowed al-Tusi's model to make the shocking proposition that the Earth revolves around the sun. "Al-Tusi made his observations without telescopes or even glasses," says Djebbar.

LOCATION: Prof. Sami Haddad, Beirut, Lebanon.

REFERENCES:

*Needham, J., *Science and Civilisation in China*, Volume 3, pp. 561-562.

*illustrated