Climatic Change (2007) 81:469–475
DOI 10.1007/s10584-006-9199-y

Circa A.D. 626 volcanic eruption, climatic cooling, and the collapse of the Eastern Turkic Empire

Jie Fei · Jie Zhou · Yongjian Hou

Received: 9 June 2005 / Accepted: 8 September 2006 / Published online: 27 January 2007

Abstract During the late sixth century and early seventh century, the Eastern Turkic Empire (i.e., the Eastern Turkic Khanate) was the most powerful country in the Northeast Asia. It collapsed suddenly in A.D. 630, and historians concluded that the combination of social, political and economic factors, as well as the invasion of the Tang Empire, would be the root cause. Here we suggest that a climatic cooling event ca. A.D. 627–629 could be the direct cause. In A.D. 627–629, the Eastern Turkic Empire experienced severe disasters of snow and frost. Many of the sheep and horses died. People suffered great famine and massive deaths. The Empire fell into severe national crisis and collapsed in A.D. 630. Simultaneously, the Tang Empire also experienced three successive years of frost disasters. Climatic cooling possibly also occurred in other regions. Our investigation of the ca. A.D. 627–629 climatic cooling event also improved our understanding of another problem: was the climatic event due to the impact of a ca. A.D. 626 volcanic eruption?

1 Introduction

Sudden societal collapses in historical times have been discussed intensively by historians and archaeologists, commonly leading to conclusions that combinations of social, political and economic factors were their root causes (Weiss and Bradley 2001). However, abrupt climatic change has been recognized to be an important direct cause of some societal

J. Fei (✉)
Department of History of Science and Technology and Archaeometry,
University of Science and Technology of China, 96 Jinzhai Road, Hefei 230026, China
e-mail: jiefei@ustc.edu.cn

J. Fei · J. Zhou
State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment,
Chinese Academy of Sciences, Xi'an 710075, China

Y. Hou
Institute of Chinese Historical Geography, Shaanxi Normal University, Xi'an 710062, China

collapses (Weiss 1982; DeMenocal 2001; Weiss and Bradley 2001; Alley et al. 2003; Haug et al. 2003; O'Connor and Kiker 2004). A climatic cooling event occurring in the late 620's in a great steppes empire, the Eastern Turkic Empire (i.e., the Eastern Turkic Khanate. ca. A.D. 581–630), will be traced in this paper, utilizing mostly Chinese historical sources.

2 Exceptional disasters and the collapse of the Eastern Turkic Empire

The Turks were one of the three most powerful nomadic peoples in the history of the Asian steppes. In ca. A.D. 552, a powerful Turkic Empire was established. Three decades later, in ca. A.D. 581, the Empire split into two parts, i.e., the Eastern Turkic Empire (Henceforward ETE) and the Western Turkic Empire (Fig. 1).

During the late sixth century and early seventh century, the ETE became the most powerful country in the Northeast Asia. Rulers in adjacent areas all submitted to the rule of the ETE, including probably the Tang Empire (A.D. 618–907) (Chen 1951; Wu 1998).

Incredibly, the powerful ETE suddenly collapsed in A.D. 630. Historians concluded that the combination of various social, political and economic factors as well as the invasion of the Tang Empire caused the collapse of the ETE (Grousset 1939; Lü 1959; Twitchett 1979; Cen 1982; Wu 1998). Here we suggest that an abrupt climatic cooling event in A.D. 627–629 could be a direct cause. From about A.D. 627 to A.D. 629, the ETE suffered sudden and very severe disasters of snow and frost as well as ensuing great famines and plagues. The relevant Chinese historical records are as follows. It is noteworthy that the ETE was generally called 'Turk' in Chinese literatures.

Jiutangshu (Vol. 194) Zhenguan reign period; first year (Jan. 23, 627–Feb. 10, 628 A.D.). That country (ETE) experienced exceptionally heavy snowfalls. There were several *chi* of

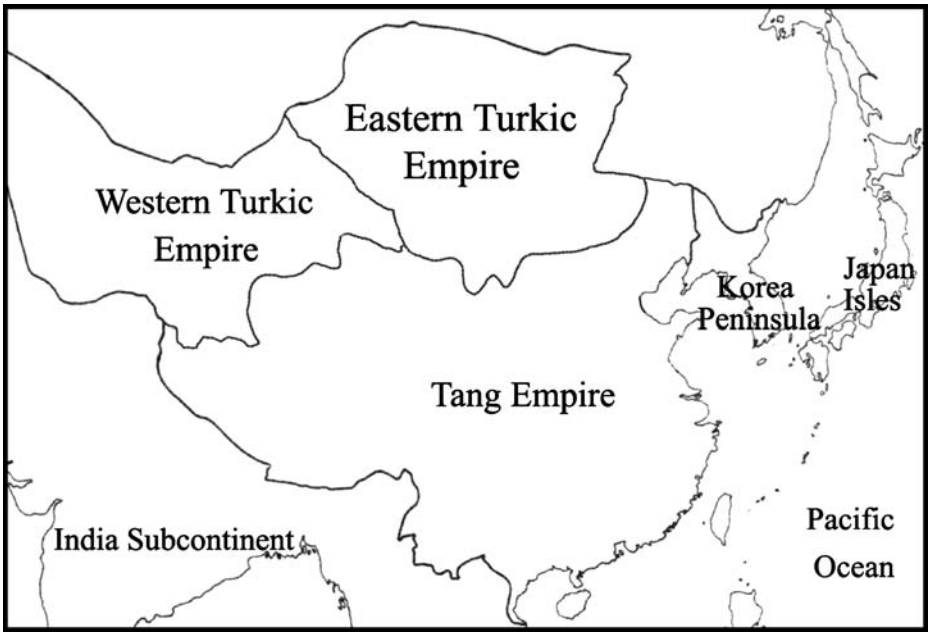

Fig. 1 Schematic map showing the approximate location and territory of the Eastern Turkic Empire

snow on the ground (*chi* is a linear measure of China. 1 *chi*≈0.3 m). Many sheep and horses died. People suffered great famine.

Jiutangshu (Vol. 194) Zhenguan reign period; third year (Jan. 30, 629–Feb. 17, 630 A.D.). There were disasters of snow for several consecutive years (in the ETE). All of the livestock died. There was a great famine in the country. Xieli (the Khan, i.e., Emperor, of ETE) fell into a perplexity of budget deficit. The taxes were still raked in rapaciously, and the tribes fell off still more.

Xintangshu (Vol. 228) (*Zhenguan* reign period; first year, i.e., Jan. 23, 627–Feb. 10, 628 A.D.). That year there was a great snow (in the ETE). Many of the sheep and horses were frozen to death. People suffered famine.

Xintangshu (Vol. 228) (*Zhenguan* reign period; second year, i.e., Feb. 11, 628–Jan. 29, 629 A.D.) The Tang Emperor said, 'Turk had a frost in high summer...Great famine occurred. The taxes were still raked in rapaciously, and the tribes fell off still more.'

Zizhitongjian (Vol. 192) (*Zhenguan* reign period; first year; sometime between the day *renzi* in the seventh month (Aug. 18, 627 A.D.) and the day *wuxu* in the eighth month (Oct. 3, 627 A.D.)). (The Tang Emperor discussed the Turkic problem with his officials.) Exceptionally heavy snowfalls occurred (in the ETE). The snow was several *chi* deep. All livestock died. Great famine ensued for several consecutive years. People all died of hunger and coldness. The Empire fell into a perplexity of budget deficit. The taxes were still raked in rapaciously, and the tribes fell off still more.

Zizhitongjian (Vol. 192) (At the end of the first year of *Zhenguan* reign period (Jan. 23, 627–Feb. 10, 628 A.D.)) Turk (ETE) weakened even more greatly. Citizens fled the country. It experienced exceptional heavy snowfalls. Snow on the ground was several *chi* deep. Sheep and horses all died. A great famine ensued.

Zizhitongjian (Vol. 193) Zhenguan reign period; third year (Aug. 24, 629–Sept. 21, 629 A.D.). An official, *Gongjin Zhang*, reported to the Tang Emperor. He presented six conditions favorable for invading Turk....The fourth one was that unusually early frosts occurred in autumn, and people suffered great famine in the steppes....

Cefuyuangui (Vol. 125) Zhenguan reign period; second year (Feb. 11, 628–Jan. 29, 629 A.D.). The Tang Emperor said, 'mid-summer frosts occurred in Turk.'

Taipingyulan (Vol. 878) In the beginning of the *Zhenguan* reign period. There was a frost in Turk in the fifth month (about June).

The disasters of snow and frost killed the sheep and horses, which were of vital importance to nomadic societies. Nationwide great famine occurred in the ETE. The causal connection between the disasters of snow and frost and the ETE collapse can be seen from the following records.

Jiutangshu (Vol. 62) Ever since the *Yining* reign period (Dec. 4, 617–Apr. 29, 618 A.D.), *Yuanshou Zheng* had been sent as an envoy to Turk for five times....In the third year of the *Zhenguan* reign period (Jan.30, 629–Feb. 17, 630 A.D.), he was sent to Turk again. When he

came back, he reported to the Tang Emperor, 'the rise and fall of Turk depend on sheep and horses. At present, the livestock become thin and weak. People are emaciated...Turk will definitely collapse in 3 years.'

Zizhitongjian (Vol. 192) An official, *Yuanshou Zheng*, reported to the Tang Emperor, the rise and decline of the northern nomadic countries depend on sheep and horses. In Turk, the live stocks were withering and people were starving now. These were signs of decline. It would fall in less than 3 years.

Massive deaths occurred in the ETE. *Cefuyuangui* (Vol. 42) recorded the mortality crisis in the ETE.

(*Zhenguan* reign period) fourth year; ninth month (Oct.12–Nov. 9, 630 A.D.). The Tang Emperor issued an edict. 'The Turkic tribes suffered great disasters, a great many people died of famine and plague. Large number of corpses littered the field everywhere...'

The ETE fell into severe national crisis and collapsed soon. We suggest that the disasters of snow and frost should be a direct cause of the ETE collapse, though climate itself should not be the sole factor of the ETE collapse.

3 Circa 626 A.D. volcanism

Volcanism is an important cause of climatic cooling (Mann et al. 1998; Bertrand et al. 1999; Crowley 2000). Historical sulfur-producing volcanic eruptions have been proved to be followed by abrupt short-term climatic cooling of several years long (Self et al. 1981; Angell and Korshover 1985; Briffa et al. 1998; Stothers 1999; Zielinski 2000). It seems that the climatic cooling event at A.D. 627–629 may possibly also have a volcanic cause.

A major volcanic eruption at A.D. 623 ±3 was revealed in the Crête ice core, although the volcanic eruptions prior to A.D. 900 revealed in the Crête record have not been ascribed to known eruptions, including the highest signal of A.D. 623 ±3 (Hammer et al. 1980). Evidences possibly also exist in the GRIP and GISP2 ice cores in Greenland (Zielinski et al. 1994; Clausen et al. 1997).

Notwithstanding the poor record keeping endemic to the Dark Ages in Europe, fragmental documentation of atmospheric anomalies exists. Extensive searches of relevant entries scattered through European (and some Near Eastern) historical sources confirmed the possible effects of the unidentified volcanic eruption revealed in the Crête record. A prolonged and widespread volcanic dry fog, starting in the October of about A.D. 626 (with an uncertainty of ±1 year) and lasting 8–9 months, dimmed the sun over Ireland and the eastern Mediterranean (Stothers and Rampino 1983a,b; McCarthy and Breen 1997; Stothers 1999, 2002). Distant ash fall in A.D. 626 at Constantinople was also recorded in European historical sources (Stothers and Rampino 1983b).

However, although scientists exhaustively searched European historical records about the climatic effects of this volcanic eruption, the results did not give a detailed picture (Stothers 1999). Stothers (2002) suggested that unusually cold and rainy weather broke out in Japan during the summer of A.D. 626 after searching Japanese historical sources. A notable frost ring event in A.D. 628 in the western USA has also been suggested (LaMarche and Hirschboeck 1984). However, D'Arrigo et al. (2001) did not find frost ring or light ring events in Mongolian or Siberian tree ring records. According to several of the near Eastern

chroniclers, unusually cold winters occurred around this time, but none could be assigned specifically to the A.D. 626–627 period (Stothers and Rampino 1983b).

Chinese historical sources pertaining to the medieval period are unique and very substantial. Evidence of the climatic cooling event in the ETE greatly improved our appreciation of the possible climatic impact of the ca. A.D. 626 A.D. volcanic eruption. Besides, there is evidence of climatic cooling at A.D. 627–629 in the Tang Empire.

4 Climatic cooling in the Tang Empire

From A.D. 627 to 629, successive disasters of frost occurred in the Tang Empire. Different sources of Chinese historical records concerning this climatic cooling event are found in detail. Climatic cooling began in A.D. 627 and persisted until A.D. 629.

Cefuyuangui (Vol. 144) Zhenguan reign period; first year; seventh month (Aug. 17 627–Sept. 14, 627 A.D.). A frost disaster destroyed the harvests in the Guandong, Henan, and Longyou provinces, as well as the northern border areas.

Jiutangshu (Vol. 2) Zhenguan reign period; first year; eighth month (Sept. 15, 627–Oct. 14, 627 A.D.). A frost disaster destroyed the harvests in the Guandong, Henan, and Longyou provinces, as well as the northern border areas.

Xintangshu (Vol. 2) Zhenguan reign period; first year; eighth month (Sept. 15, 627–Oct. 14, 627 A.D.). A frost disaster occurred in the Henan and Longyou provinces, as well as the northern border areas.

Xintangshu (Vol. 36) Zhenguan reign period; first year (Jan. 23, 627–Feb. 10, 628 A.D.); autumn. A frost disaster destroyed harvests.

Jiutangshu (Vol. 2) Zhenguan reign period; second year; eighth month (Sept. 3, 628–Oct. 2, 628 A.D.). A great frost disaster occurred and famine ensued in Henan and Hebei provinces.

Xintangshu (Vol. 36) Zhenguan reign period; third year (Jan. 30, 629–Feb. 17, 630 A.D.). A frost disaster destroyed harvests in the northern border areas.

After A.D. 629, there were no records pertaining to unusual cold weather but good harvests records:

Zizhitongjian (Vol. 193) Zhenguan reign period; fourth year (Feb. 18, 630–Feb. 6, 631 A.D.). Very good harvests.

Jiutangshu (Vol. 23) Zhenguan reign period; sixth year (Jan. 27, 632–Feb. 13, 633 A.D.). Several successive years of good harvests.

Accordingly, it is reasonable to deduce that the successive disasters of frost ended in A.D. 629.

5 Conclusion

Utilizing Chinese historical records, a highly disruptive ca. A.D. 626 climatic cooling event was investigated. The Eastern Turkic Empire in the Northeast Asia suffered exceptional disasters

of snow and frost. Sheep and horses, which were of vital importance to nomadic societies, all died. People suffered great famine and massive deaths. The Empire thus fell into severe national crisis and collapsed soon. This climatic cooling event could be a direct cause of the sudden collapse of the powerful Eastern Turkic Empire in A.D. 630, thus greatly changed the political map in the Northeast Asia and ended a glorious epoch of the Turkic history.

In A.D. 627–629, successive disasters of frost also occurred in the Tang Empire. Synthesizing various evidences, the ca. A.D. 627–629 climatic cooling event seemed to be widespread in the Northeast Asia possibly other regions, whereas the Eastern Turkic Empire was possibly the worst affected region. On the other hand, all of these improved the understanding of the climatic impact of an extensively investigated yet insufficiently succeeded volcanic eruption, i.e., the ca. A.D. 626 volcanic eruption.

6 Notes

Jiutangshu is an official chronicle of the Tang Dynasty (618–907 A.D.). It totals 200 volumes. The compilation was commenced at imperial request, and it was accomplished in 945 A.D. The chief compiler is *Xu Liu*. Beijing: Chinese Press (*Zhonghua Shuju*), 1975 (in Chinese).

Xintangshu is an official chronicle of the Tang Dynasty (618–907 A.D.). It totals 225 volumes. The compilation was commenced at imperial request, and it was accomplished in 1060 A.D. The chief compilers are *Qi Song* and *Xiu Ouyang*. Beijing: Chinese Press, 1975 (in Chinese).

Zizhitongjian is a chronicle of China from 403 B.C. to 959 A.D. laying emphasis on political history. The compilation was commenced at imperial request, and it was accomplished in 1084 A.D. The chief compiler is *Guang Sima*. Beijing: Chinese Press, 1963 (in Chinese).

Cefuyuangui is an encyclopedia of ancient China (prior to 960 A.D.). It totals 1,000 volumes. The compilation was commenced at imperial request, and it was accomplished in 1013 A.D. The chief compiler is *Qinruo Wang*. Beijing: Chinese Press, 1960 (in Chinese).

Taipingyulan is an encyclopedia of ancient China (prior to 960 A.D.). It totals 1,000 volumes. The compilation was commenced at imperial request, and it was accomplished in 984 A.D. The chief compiler is *Fang Li*. Beijing: Chinese Press, 2002 (in Chinese).

Acknowledgements We are grateful to Professors Richard B. Stothers and Stephen Self for the helpful and constructive comments and suggestions. This study was supported by the Chinese Academy of Sciences (Grant no. KZCX3-SW-146).

References

Alley RB, Marotzke J, Nordhaus WD, Overpeck JT, Peteet DM, Pielke RA Jr, Pierrehumbert RT, Rhines PB, Stocker TF, Talley LD, Wallace JM (2003) Abrupt climatic change. Science 299:2005–2010

Angell JK, Korshover J (1985) Surface temperature changes following six major volcanic episodes between 1780 and 1980. J Clim Appl Meteorol 24:937–951

Bertrand C, van Ypersele J-P, Berger A (1999) Volcanic and solar impacts on climate since 1700. Clim Dyn 15:355–367

Briffa KR, Jones PD, Schweingruber FH, Osborn TJ (1998) Influence of volcanic eruptions on Northern Hemisphere summer temperature over the past 600 years. Nature 393:450–455
Cen Z (1982) History of the Sui and Tang dynasties. Chinese (*Zhonghua Shuju*), Beijing (in Chinese)
Chen Y (1951) The submission of the Emperor Gaozu of the Tang Empire to the rule of the Turks. Lingnan J 11:1–9 (in Chinese)
Clausen HB, Hammer CU, Hvidberg CS, Dahl-Jensen D, Steffensen JP, Kipfstuhl J, Legrand MR (1997) A comparison of the volcanic records over the past 4000 years from the Greenland Ice Core Project and Dye 3 Greenland ice cores. J Geophys Res 102:26707–26723
Crowley TJ (2000) Causes of climate change over the past 1000 years. Science 289:270–277
D'Arrigo, R, Frank D, Jacoby G, Pederson N (2001) Spatial response to major volcanic events in or about 536, 934 and 1258: frost rings and other dendrochronological evidence from Mongolia and Northern Siberia. Clim Change 49:239–246
DeMenocal PB (2001) Cultural responses to climate change during the late Holocene. Science 292:667–673
Grousset R (1939) L'Empire des Steppes. (See the Chinese translation) Commercial (2002), Beijing
Hammer CU, Clausen HB, Dansgaard W (1980) Greenland ice sheet evidence of post-glacial volcanism and its climatic impact. Nature 288:230–235
Haug GH, Günther D, Peterson LC, Sigman DM, Hughen KA, Aeschlimann B (2003) Climate and the collapse of Maya civilization. Science 299:1731–1735
LaMarche VC Jr, Hirschboeck KK (1984) Frost rings in trees as records of major volcanic eruptions. Nature 307:121–126
Lü S (1959) History of the Sui, Tang, and the five dynasties. Chinese (*Zhonghua Shuju*), Beijing (in Chinese)
Mann ME, Bradley RS, Hughes MK (1998) Global-scale temperature patterns and climate forcing over the past six centuries. Nature 392:779–787
McCarthy D, Breen A (1997) An evaluation of astronomical observations in the Irish annals. Vistas Astron 41:117–138
O'Connor TG, Kiker GA (2004) Collapse of the Mapungubwe society: vulnerability of pastoralism to increasing aridity. Clim Change 66:49–66
Self S, Rampino M, Barbera JJ (1981) The possible effects of large 19th and 20th century volcanic eruptions on zonal and hemispheric surface temperatures. J Volcanol Geotherm Res 11:41–60
Stothers RB (1999) Volcanic dry fogs, climate cooling, and plague pandemics in Europe and the Middle East. Clim Change 42:713–723
Stothers RB (2002) Cloudy and clear stratospheres before A.D. 1000 inferred from written sources. J Geophys Res 107(D23):4718(doi: http://dx.doi.org/10.1029/2002JD002105, 2002)
Stothers RB, Rampino MR (1983a) Historic volcanism, European dry fogs, and Greenland acid precipitation, 1500 B.C. to A.D. 1500. Science 222:411–413
Stothers RB, Rampino MR (1983b) Volcanic eruptions in the Mediterranean before 630 A.D. from written and archaeological sources. J Geophys Res 88:6357–6371
Twitchett D (1979) The Cambridge history of China: Volume 3, Sui and Tang China, 589–906 A.D. Cambridge University Press, UK
Weiss B (1982) The decline of late bronze age civilization as a possible response to climatic change. Clim Change 4:173–198
Weiss H, Bradley RS (2001) What drives societal collapse? Science 291:609–610
Wu Y (1998) An investigation into the history of the relationship between the Turkic Khanate and the Sui-Tang Empires. Chinese Social Sciences, Beijing (in Chinese)
Zielinski GA (2000) Use of paleo-records in determining variability within the volcanism-climate system. Quat Sci Rev 19:417–438
Zielinski GA, Mayewski PA, Meeker LD, Whitlow S, Twicker MS, Morrison M, Meese D, Alley RB, Gow AJ (1994) Record of volcanism since 7000 B.C. from the GISP2 Greenland ice core and implications for the volcano-climate system. Science 264:948–952