Global environmental catastrophe at about 2300 Ma

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It was found that the sedimentary *REE* patterns had changed at 2300 Ma at the southern margin of North China Craton (Chen and Zhao, 1997), resulting from the variation in oxygen fugacity of the hydrosphere and atmosphere. Since this discovery, we have studied comprehensively the changes in surficial environment at this time, and obtained a series of inspiring achievements which encourages us to exchange our research works and ideas with colleagues. Therefore, this paper attempts to display the evidence for a catastrophe at about 2300 Ma.

Data shown in Table 1 support the suggestion that the geological environment (including sedimentary sphere, biosphere, hydrosphere and atmosphere) underwent a global catastrophe caused by extra-terrestrial factors at about 2300 Ma. The catastrophe resulted in an obvious weakening of volcanism, the formation of an O_2-rich atmosphere, a leap in palaeontological evolution, a sharp decrease in climatic temperature, and some other subsequent changes in rocks, ore deposits and element distributions.

Our summary of these changes supports the points of view of Frakes (1979), Kasting (1993) and Schidlowski (1983). They had also argued that the atmosphere became oxidic from anoxic during the Palaeoproterozoic, especially around 2300 Ma.

Now the time for environmental change is tentatively determined at 2300 Ma, the proof is as follows: (1) the strata over the boundary have not yet acquired convincing isotopic ages more than 2300 Ma; (2) the upper age limit of deposition for the Witwatersrand supergroup before the catastrophe is 2340 Ma (Rb-Sr isochron dating) (Frakes, 1979), and the Rb-Sr isochron age of the tuff interbeds in the Elliot Lake Group in the bottom of Huronian supergroup is 2330 Ma, they both abound with Rand-type Au-U deposits, so the catastrophe probably took place after 2330 Ma. The Cobalt Group, the topmost strata of the Huronian Supergroup, containing red beds, evaporates and carbonate rocks, showing clear negative sedimentary Eu-anomalies, was obviously formed after the catastrophe and dated at 2288 ± 77 Ma (Rb-Sr isochron age for whole rocks) (Mossman and Harron, 1983), which indicates that the catastrophe took place before 2288 Ma. Hence, the catastrophe might occur between 2330 Ma and 2288 Ma, i.e. 2300 ± 30 Ma.

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References

Chen, Y.J. and Zhao, Y.C. (1997) *Episodes*, **20**, 109–16.

Frakes, L.A. (1979) *Climates throughout Geologic Time*. Elsevier, Amsterdam, 310 pp.

Kasting, J.F. (1993) *Science*, **259**, 920–6.

Schidlowski, M. (1983) *Precamb. Res.*, **20**, 319–35

Mossman, D.J. and Harron, G.A. (1983) *Precamb. Res.*, **20**, 543–83.

TABLE. 1. Changes of the surface system of the Earth before 2300 Ma and after 2300 Ma

Before 2300 Ma	After 2300 Ma (mainly before 1900 Ma)
Sporadic evidence of life.	Universal stramatolites.
Locally thin BIFs bearing pyrite, dominant magnetite, little hematite.	Worldwide thick BIFs dominantly composed of hematite, limonite.
No thick carbonate strata; deficient in magnesite deposit.	Extensively thick carbonate strata; lot of magnesite deposits such as the Dashiqiao superlarge magnesite deposit.
No phosphorite level older than 2300 Ma.	Phosphorite and phosphorus deposits usually seen.
No well documented evaporite.	Appearance of evaporite such as gypsum in Liaohe Group.
Poor graphite deposit and few graphite-bearing strata.	Notable graphite deposits and graphite-bearing strata.
No red beds, no gypsum; but detrital pyrites preserved in sediments such as Witwatersrand Group.	Red beds universally developed; gypsum beds well preserved; no detrital pyrite found in normal sediments.
Rand-type gold deposits found in various continents	Rand-type gold deposits disappeared
Detrital uraninite in sediments and Rand-type Au-U deposits.	No detrital uraninite in sediments; but weathering leaching-type uranium deposits coming into being
No iron hat, no gossan- or laterite-type deposits.	Iron hats and gossan- and laterite-type deposits prevailed in differing continents after 2300 Ma.
Iron-deficient palaeosols frequently reported. Fe_2O_3/FeO value increasing upward weathering profiles.	No iron-deficient palaeosol found. Fe_2O_3/FeO value decreasing upward weathering profiles.
Sediments showing positive Eu-anomalies, low *REE* and high $(La/Yb)_N$	Sediments showing negative Eu-anomalies, high *REE* and low $(La/Yb)_N$
No sedimentary *REE* formation.	Sedimentary *REE* formations, e.g. significant *REE*-BIFs.
No well documented glacial tillite.	Lot of tillites supporting a global glacial event.
Minor khondalite series and deposits of sillimanite, kyanite, andalusite, etc.	Lot of khondalite series and deposits of sillimanite, kyanite, andalusite, etc.
Intense volcanism, few stable sedimentary basins; greenstone belts widely developed.	Volcanic gap, many stable sedimentary basins; greenstone belt absent.
Organic carbon in sediments <0.7%.	About 1.6% organic carbon in sediments.
Low U, Th, La/Sc, Th/Sc, Th/U, K_2O/Na_2O, Fe_2O_3/FeO in sediments; low $^{87}Sr/^{86}Sr$ in carbonate.	High U, Th, La/Sc, Th/Sc, Th/U, K_2O/Na_2O, Fe_2O_3/FeO in sediments; high $^{87}Sr/^{86}Sr$ in carbonate.
Atmosphere rich in low valence gases (NH_3, CH_4, PH_3, H_2S, etc.); free oxygen absent.	Atmosphere rich in high valence gases (NO_2, CO_2, SO_3, SO_2, etc.); flourished by free oxygen.
Hydrosphere rich in low valence ions (Eu^{2+}, Fe^{2+}, Mn^{2+}, etc.) and anions (SCN^-, CN^-, HS^-); low fO_2 and pH.	Hydrosphere rich in high valence ions (Eu^{3+}, Fe^{3+}, Mn^{4+}, etc.) and anions (SO_4^{2-}, CO_3^{2-}, NO_3^-, PO_4^{3-}, etc.); high f_{O_2} and pH.