Earth’s thermal cycles and geological events

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Alternative cooling and warming have occurred many times in the history of Earth since its formation. In the meantime, active and quiescent periods of geological activity have also alternatively occurred in this same planet. When Earth became hotter, it shows widespread geological activities, such as LIPs, whereas during the colder stage, it became relatively quiet without too much magma activities. Although various models have been used to explain the trigger for each of these activities, there is no consensus about the fundamental relationships between the thermal cycles and episodically geological processes. The major energy sources for Earth after ~3.8 Ga include primordial heat left from the accretion, differentiation, and the radioactive decay of heat-producing elements. Surface tectonics and magmatism control the transport of heat from the interior to the surface and most surface tectonic features of Earth are the expression of their interior dynamics. Supercontinental breakup and aggregation have occurred for many times in the Earth history, accompanied by episodic cooling and warming on the Earth surface. This breakup and aggregation regime is known as plate tectonics and is characterized by high average surface heat flow fluctuations. Based on the thermodynamic principle, a thermodynamic equilibrium equation describing the earth’s thermal cycles is established. We realized that this thermal cycle may drive Earth itself to evolve, and is the fundamental reason for the periodicity or rhythmicity of geological events such as tectonic movements, orogenies, glacial periods and biological extinctions. Following this principle, we then introduced a project of Wall Chat to compile global data or evidences using a variety of literatures in Geology of early investigations of geological events to explore the relationship between geological events and Earth’s thermal cycles. The data includes the supercontinent cycle, tectonic movement, plate tectonics, extremely hot event, extremely cold event, evaporite, marine red bed, biological evolution and extinction, sea level fluctuation, etc. The Wall Chat reveals that most of the geological events have their relation to the Earth’s thermal cycles. We found that there may exist a good correlation between the occurrence of evaporites and marine red beds and the higher temperature periods, which then provides a new perspective to understand the triggering of these events. The Wall Chat also raises an interest and important question on why are the two Great Oxidation Events (GOE) both related to the two snowball events? We have several clear objectives for the future. First, we are currently cooperating with some of the related institutes of geology to
obtain additional evidence data to fill in many of the gaps in the chat; targeted areas include Paleontology, Glaciology, evaporite and red beds. Second, to understand fully the relationship between thermal cycles and, at least, most of the great geological events. Such studies, when sufficiently constrained by event data, should lead to a greatly improved understanding of the earth evolution.