The Earth system variations during the Paleoproterozoic

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The Earth system variations during the Paleoproterozoic will be reviewed in order to explain the purpose of our project on the investigation of the Earth's environmental changes during the Paleoproterozoic.

During the Paleoproterozoic, evidence for low-latitude ice sheet has been obtained in the Transvaar Supergroup, South Africa (Evans et al., 1997), suggesting that the global glaciation (i.e., snowball Earth event) may have occurred. The Karahari manganese deposit overlying the Makganyene diamictite (the glacial unit) indicates that oxygen level of the atmosphere might have increased just after the Paleoproterozoic snowball Earth event (Kirschvink et al., 2000).

The Huronian Supergroup in Canada preserves continuous record of the environmental change during the Paleoproterozoic. While there are three glaciogenic diamictites in Huronian Supergroup, we have not known which glaciation (diamictite layer) corresponds to the Makganyene glaciation in South Africa. Because the snowball Earth event should be a global event, it is important to correlate among the glacial units of this age distributed in South Africa, Canada, US, Australia, and Finland.

Recent discovery of mass-independent isotopic fractionations (MIF) in sulfur isotopes supports the increase in the atmospheric oxygen level during 2.0-2.4 Ga (Farquhar et al., 2000). However we need more data of sulfur-MIF in order to understand exact timing and detailed behaviors of variations of the atmospheric oxygen level.

On the other hand, there is an extreme positive excursion of carbon isotopic ratio (more than 10 per mil) during 2.25-2.0 Ga, which is based mainly on the analyses of rock samples from Finland (Karhu and Holland, 1997). This implies that large amount of oxygen should have been released to the atmosphere-ocean system at that time, which is known as the Great Oxidation Event (GOE). However we do not know the relationship among GOE, the snowball Earth event, MIF of sulfur isotopes, and formation of iron and manganese deposits.

In order to understand these issues, we conducted field surveys in Canada, the United States, and South Africa in 2002 and 2003. We have investigated paleomagnetic studies of the glaciogenic deposits, sedimentological analyses for the environmental change, geochemical analyses of MIF of sulfur isotopes and carbon isotopic ratio of inorganic and organic carbon.