A Paleoproterozoic planetary suicide attempt: Did Gaia throw herself off a cliff?

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Although various studies have suggested that molecular oxygen made its first bulk appearance in Earth's atmosphere sometime between 3.8 and 2.1 billion years ago, virtually all analyses agree that the seminal event that led to the production of large quantities of free O_2 was the evolution of oxygenic photosynthesis, now known in the cyanobacteria and their descendants. Geologically, the oldest bullet-proof evidence for the presence of O_2 is the 2.22 Ga BIF-hosted Kalahari manganese member of the Hotazel formation[1], because in the oceans only free O_2 is capable of oxidizing soluble Mn^{2+} into insoluble Mn^{4+}. We suggest that the geological and/or biological arguments in support of an earlier rise in pO_2 are not as definitive as this. It is therefore productive to look for other features in the geological record immediately associated with deposition of this manganese unit that might yield clues to this oxygenation event.

The Hotazel formation was deposited in the aftermath of the Makganyene glaciation[1], which was probably the first Snowball Earth event in geological history. (We have found recently that low-latitude paleomagnetic directions in the slightly older Huronian glacials of Canada fail a small-scale fold test, leaving their paleolatitudes unconstrained.) Novel innovations in biology often grow rapidly, and sometimes explosively. We suggest, therefore, that an explosive growth of the first oxygenic phototrophs may have destroyed the methane greenhouse described by Pavlov et al.[2], thus triggering a ~70 myr long hard Snowball Earth event. Afterwards, continued action of oxygenic photosynthesis would have transformed the planet into its modern aerobic state. As a purely intrinsic disaster, this could be considered a 'suicide attempt' by the Biosphere.

References

1. Kirschvink, J. L. et al. *PNAS* **97**, 1400-1405 (2000).
2. Pavlov, A. et al., *JGR* **105**, 11981-11990 (2000).

Photochemical ozone production in the Asian outflow to the Pacific observed during PEACE aircraft campaign

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Aircraft measurements of CO, NO, NO_2, NO_y, O_3, and various other species were made during Pacific Exploration of Asian Continental Emission phase A and B (PEACE-A and B) conducted over the western Pacific in January and April-May 2002, respectively. In the lower troposphere below 2 km, enhancements of the CO mixing ratio exceeding 200 ppbv were often observed during both PEACE-A and -B, indicating the transport of pollutants from Asian continent. Although the O_3 mixing ratios did not increase in the CO-enhanced air masses in general during PEACE-A (January), enhancements of both O_3 and CO were observed in some cases. Backward trajectory analysis showed that the O_3 enhancements occurred in the the polluted air uplifted above 800 hPa over the north or central China. Negative correlation of O_3 with water vapor showed that the net photochemical O_3 production proceeded in the less humid air lifted above the surface boundary layer. In contrast with the PEACE-A cases, mixing ratios of O_3 and CO showed clear, positive correlation during PEACE-B (April-May). However, O_3 did not show positive corelation with NO_x and NO_y. Backward trajectory analysis and correlation analysis suggest that the observed positive correlation between O_3 and CO was due to the mixing of warn, humid and O_3 (and CO) poor air over subtropical western Pacific and cold, dry, O_3 (and CO) rich air transported from the free troposphere at the latitudes higher than 40N. These results are consistent with the results of the photochemical model calcuration. Comparison with the data obtained from the NASA TRACE-P aircraft observation and from the ground-based observations are also presented and discussed.