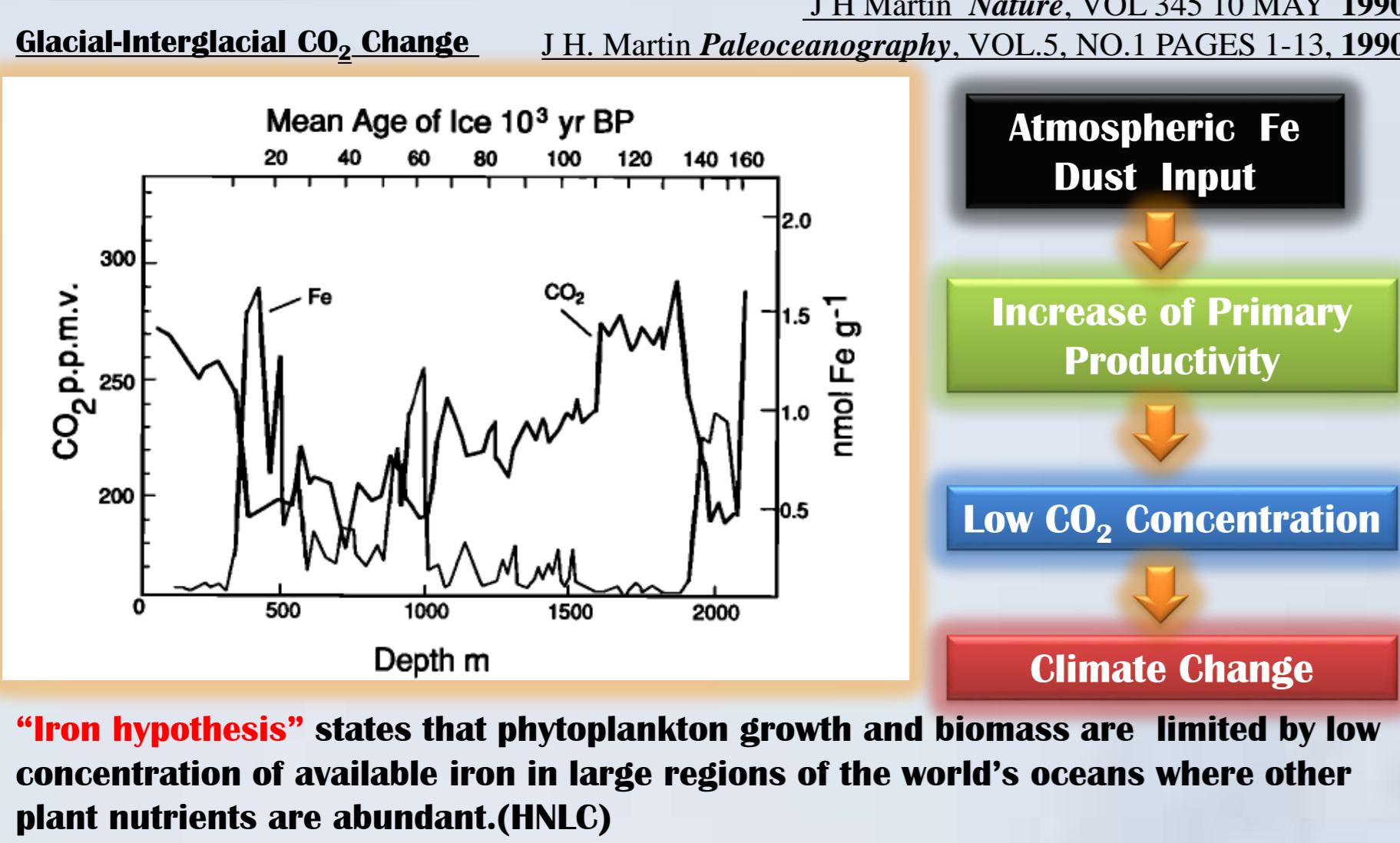
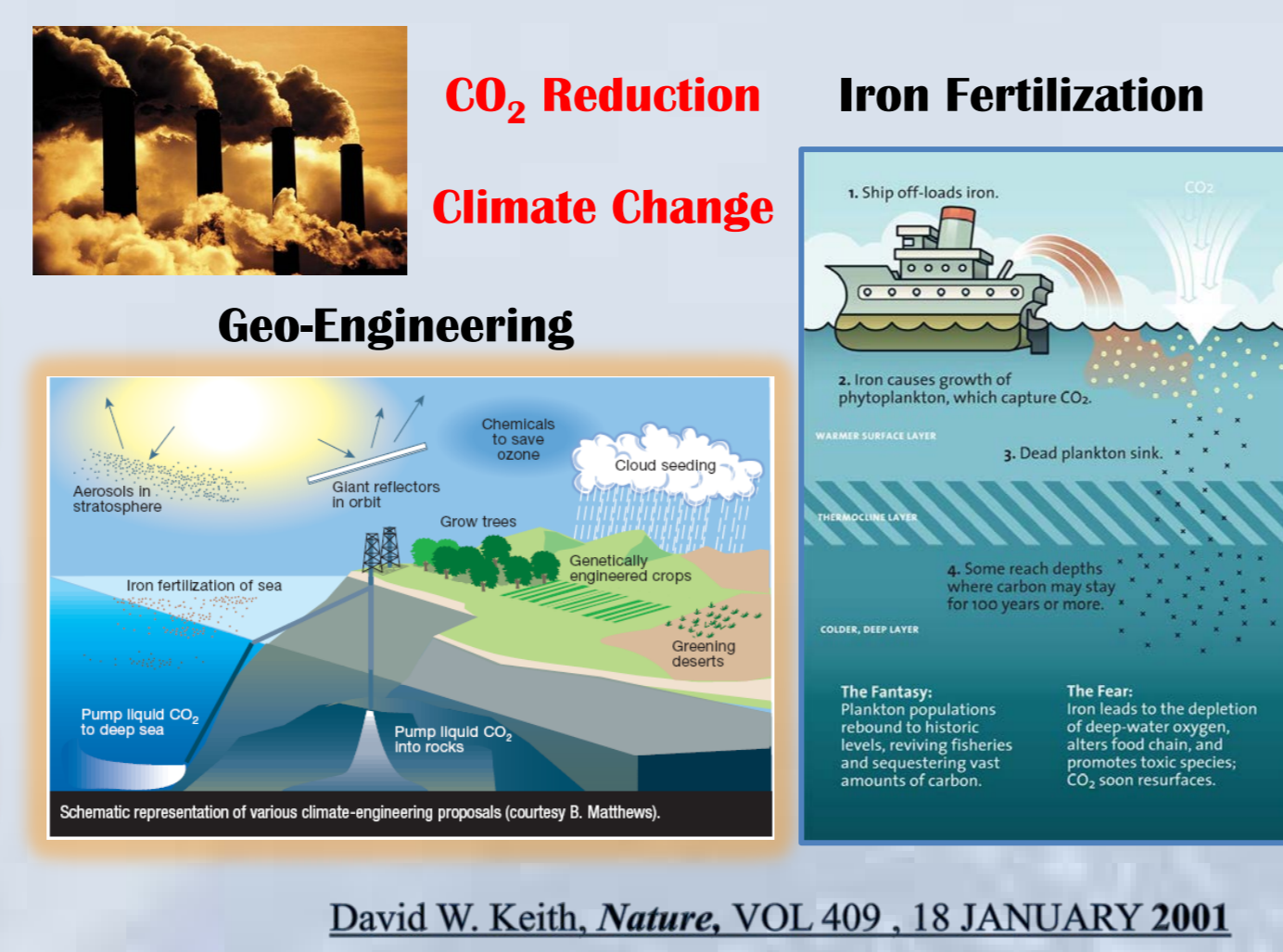


Introduction

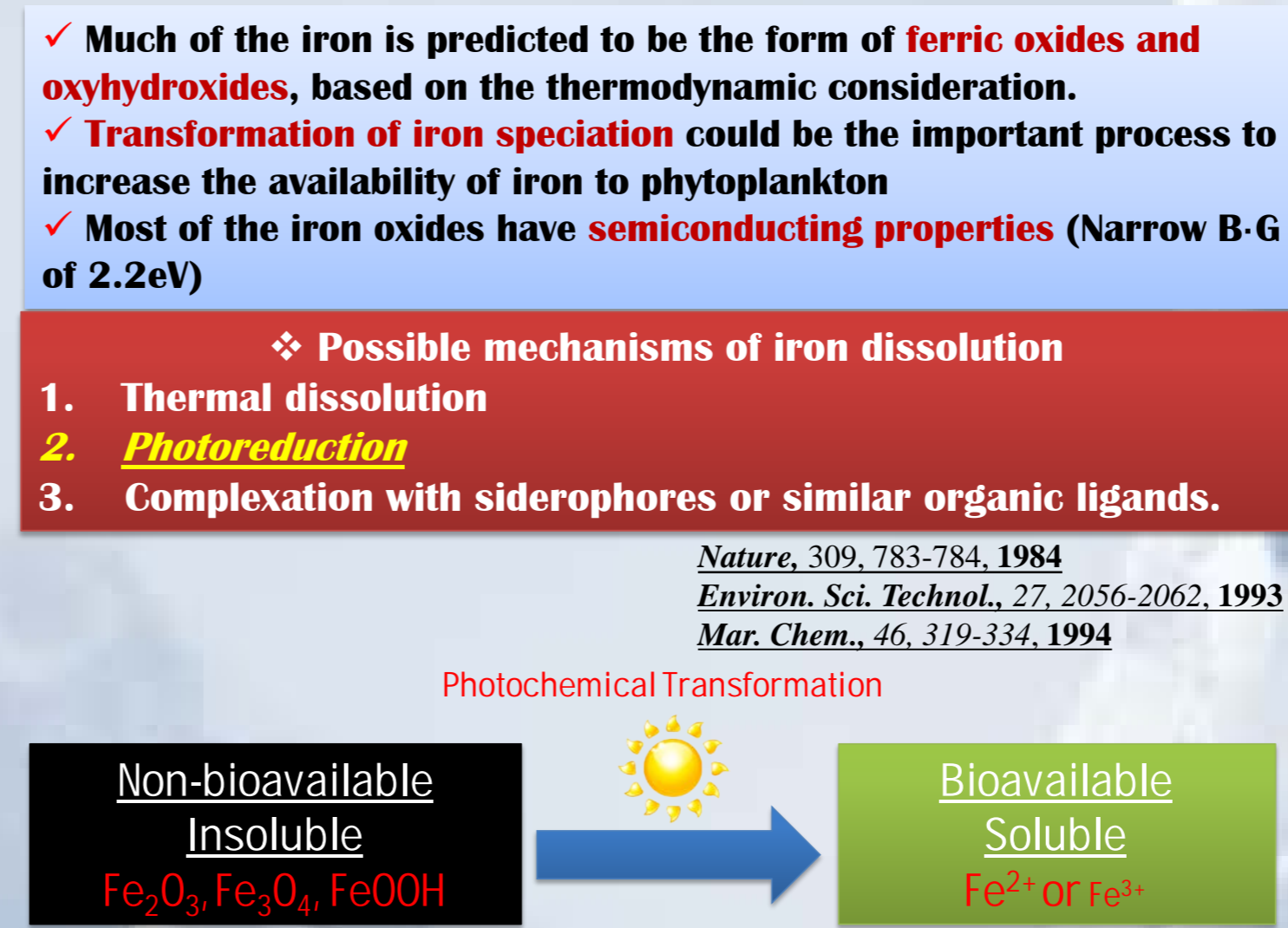
Iron Hypothesis



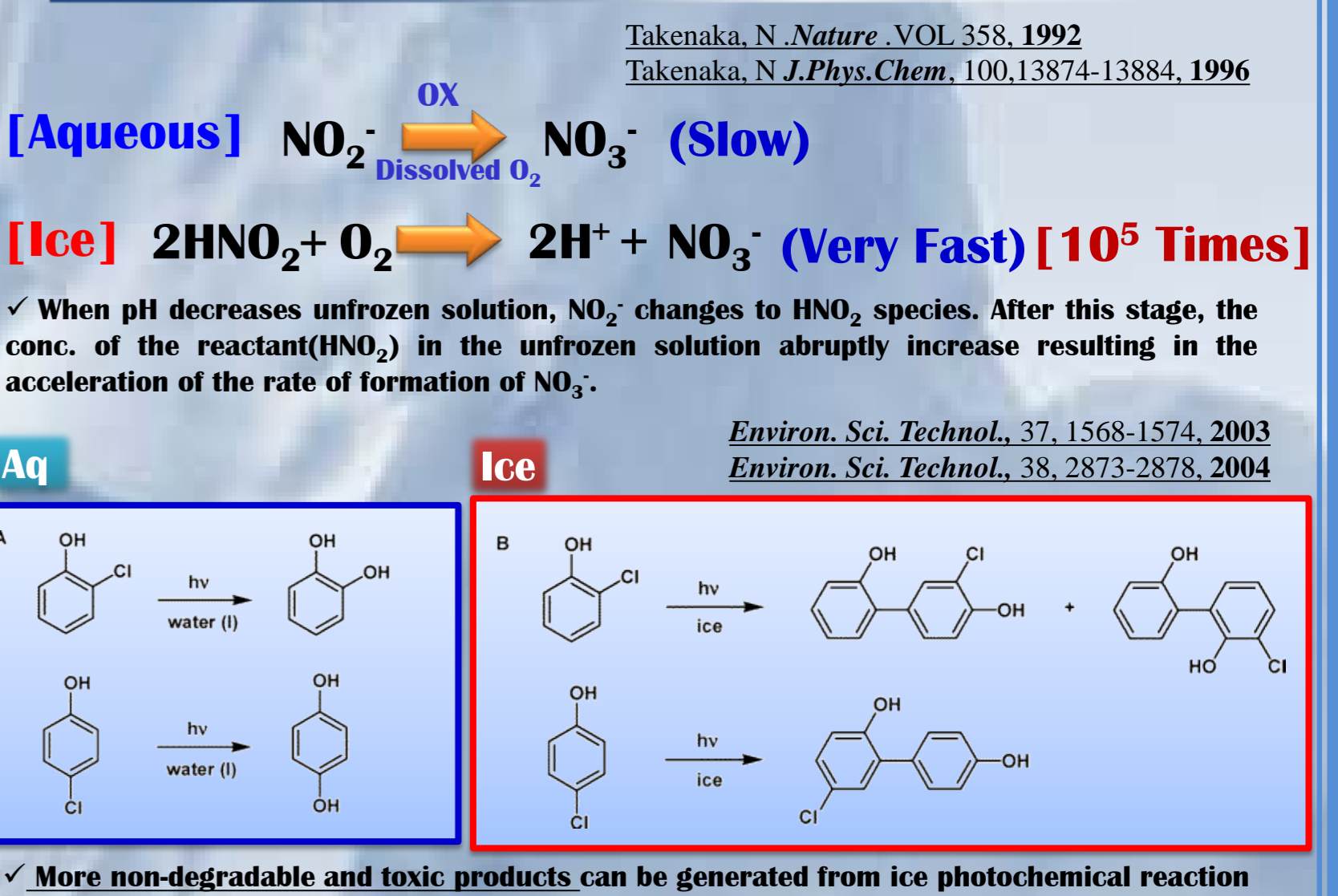
Geo-Engineering (Iron Fertilization)



Bio-availability of Iron

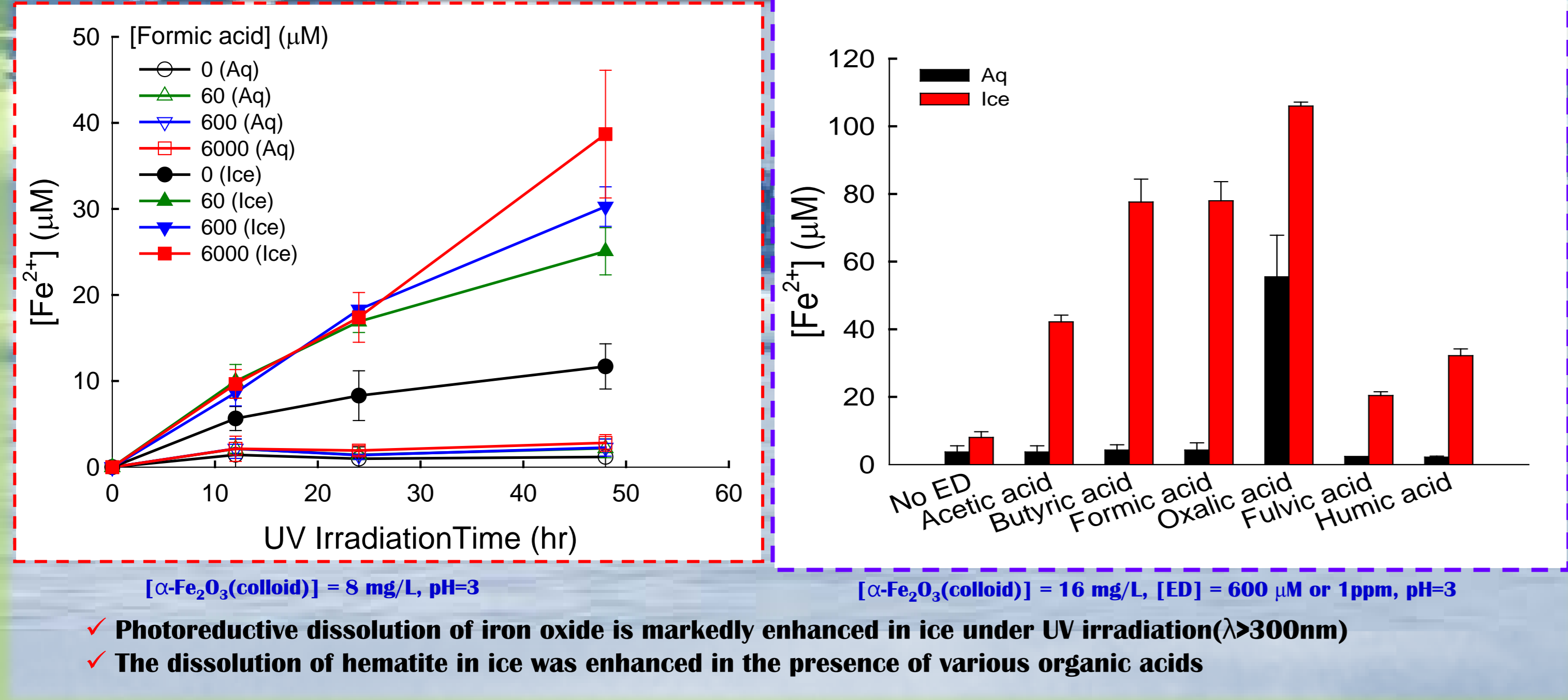


Unique Reactions in Ice Phase

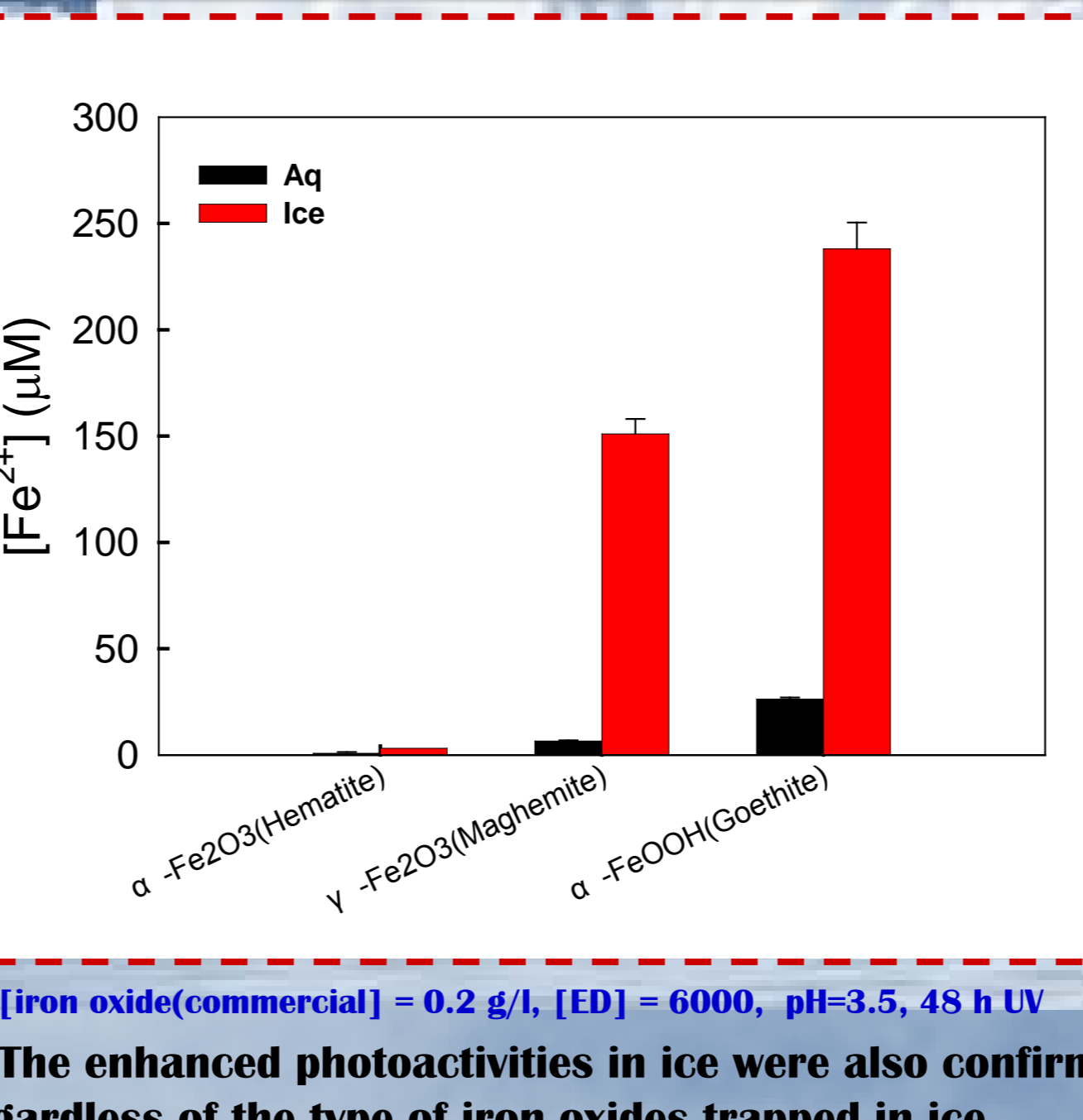


Result & Discussion

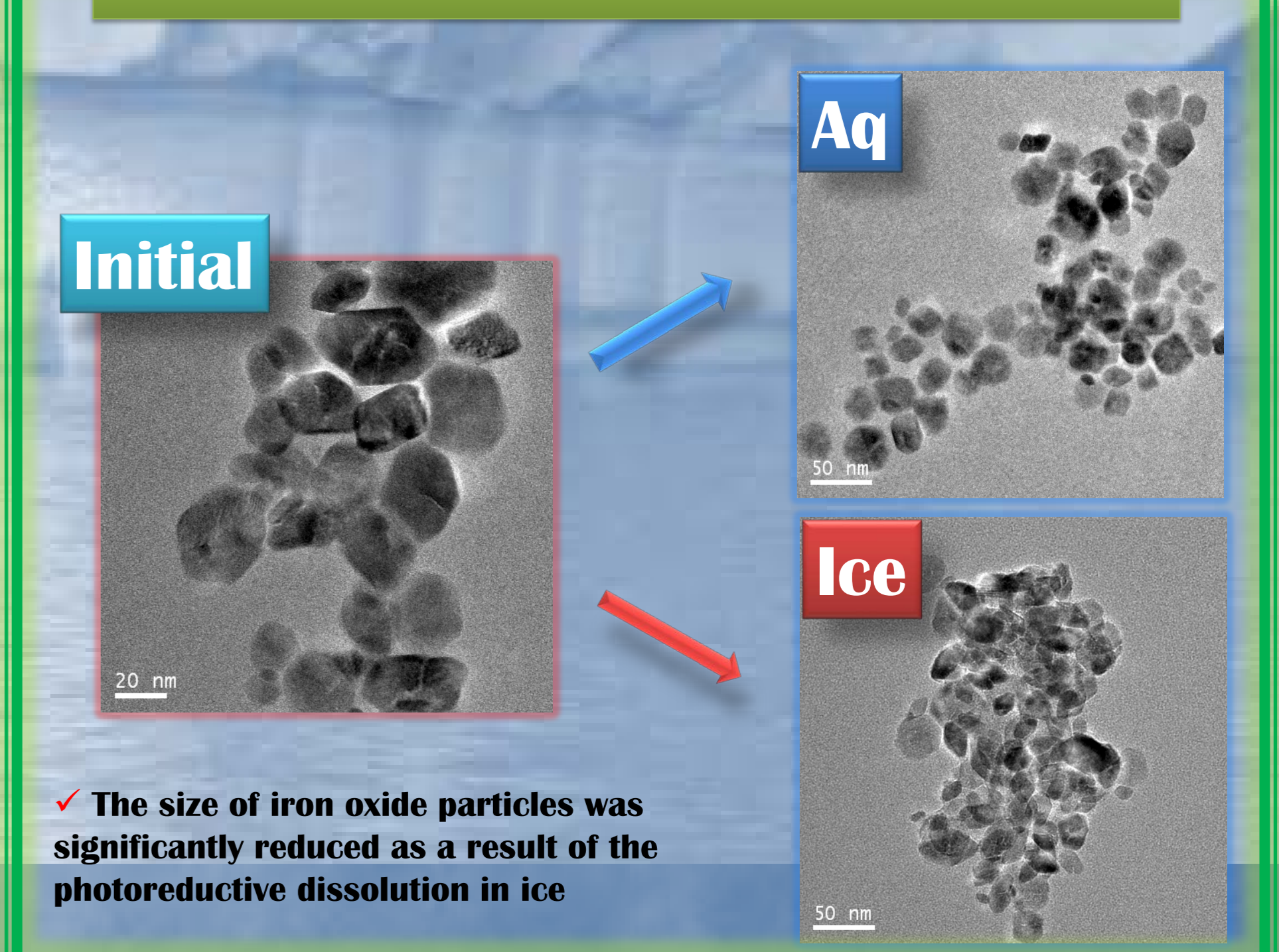
Fe(II)_{aq} Formation via Photoreductive Dissolution of Iron Oxide under UV Irradiation



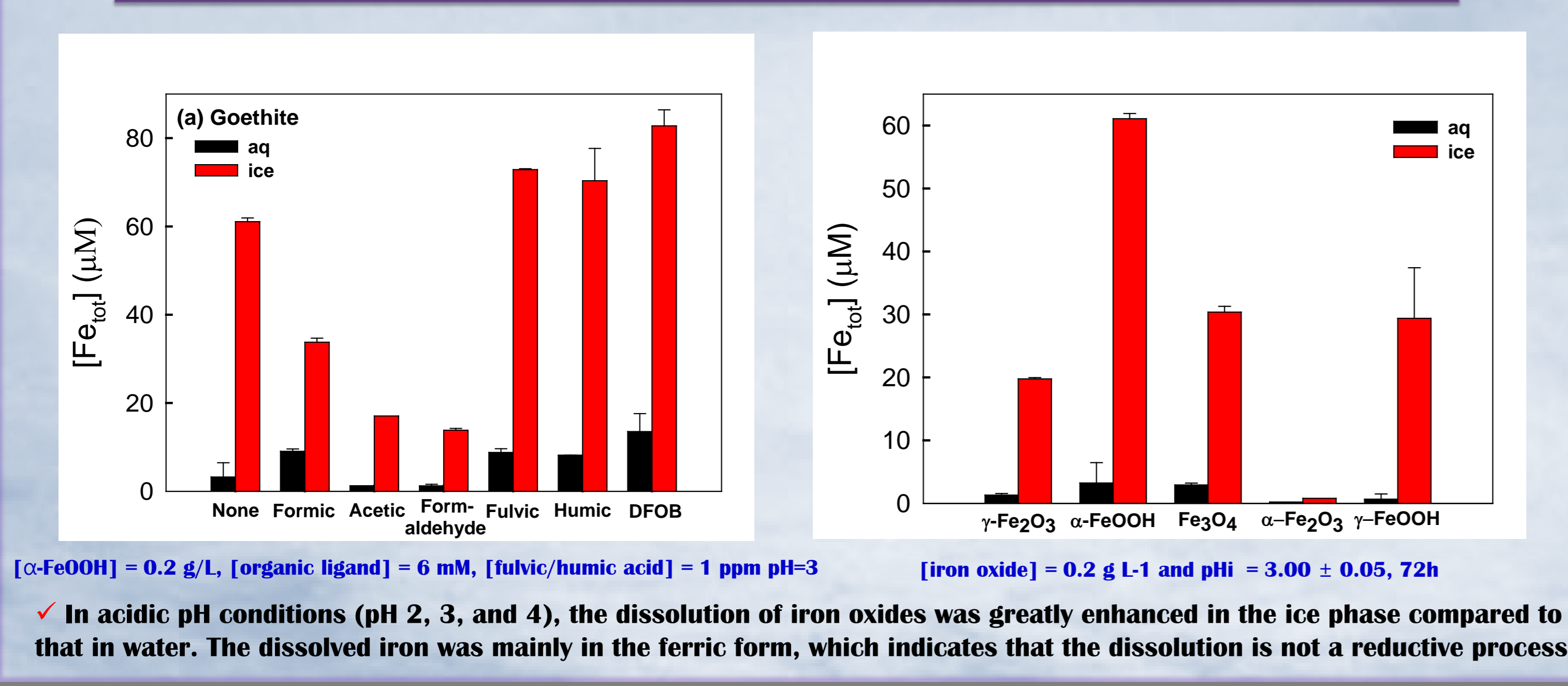
Fe(II)_{aq} Formation via Photoreductive Dissolution of Various Iron oxides



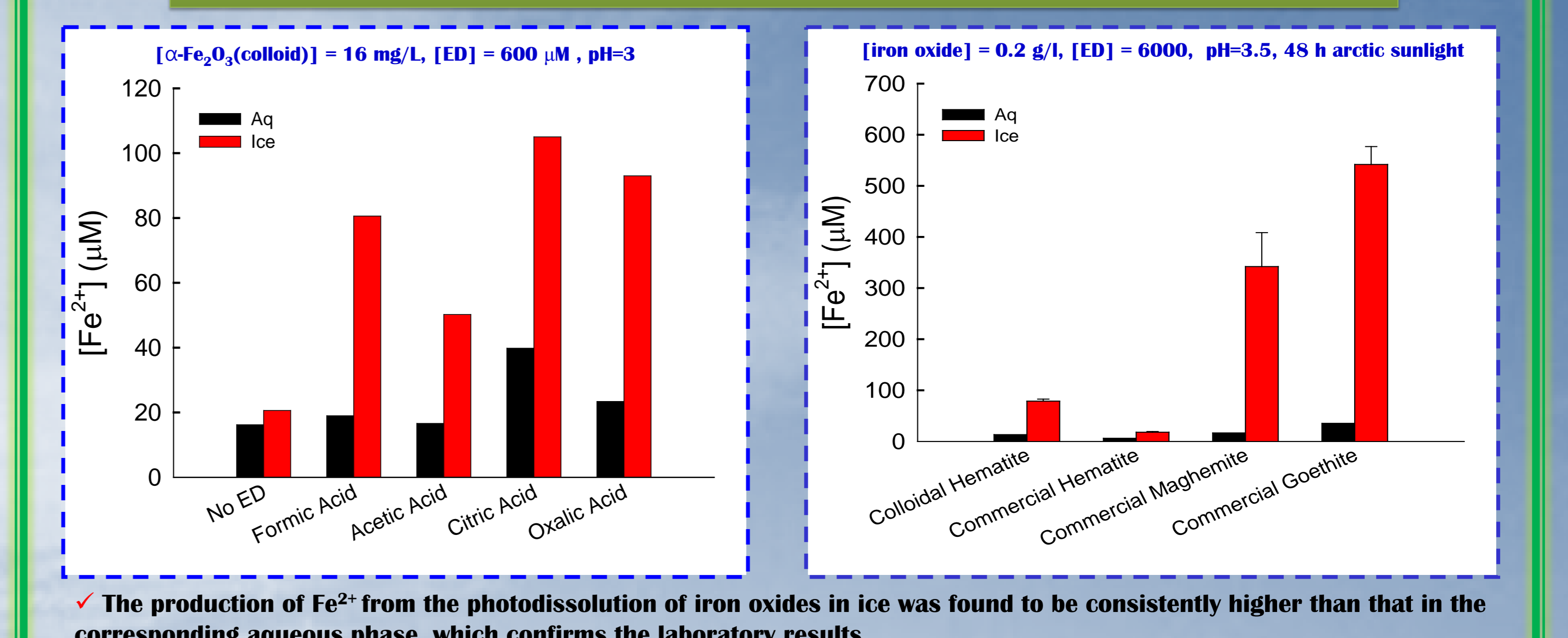
TEM Image of Hematite after Reaction



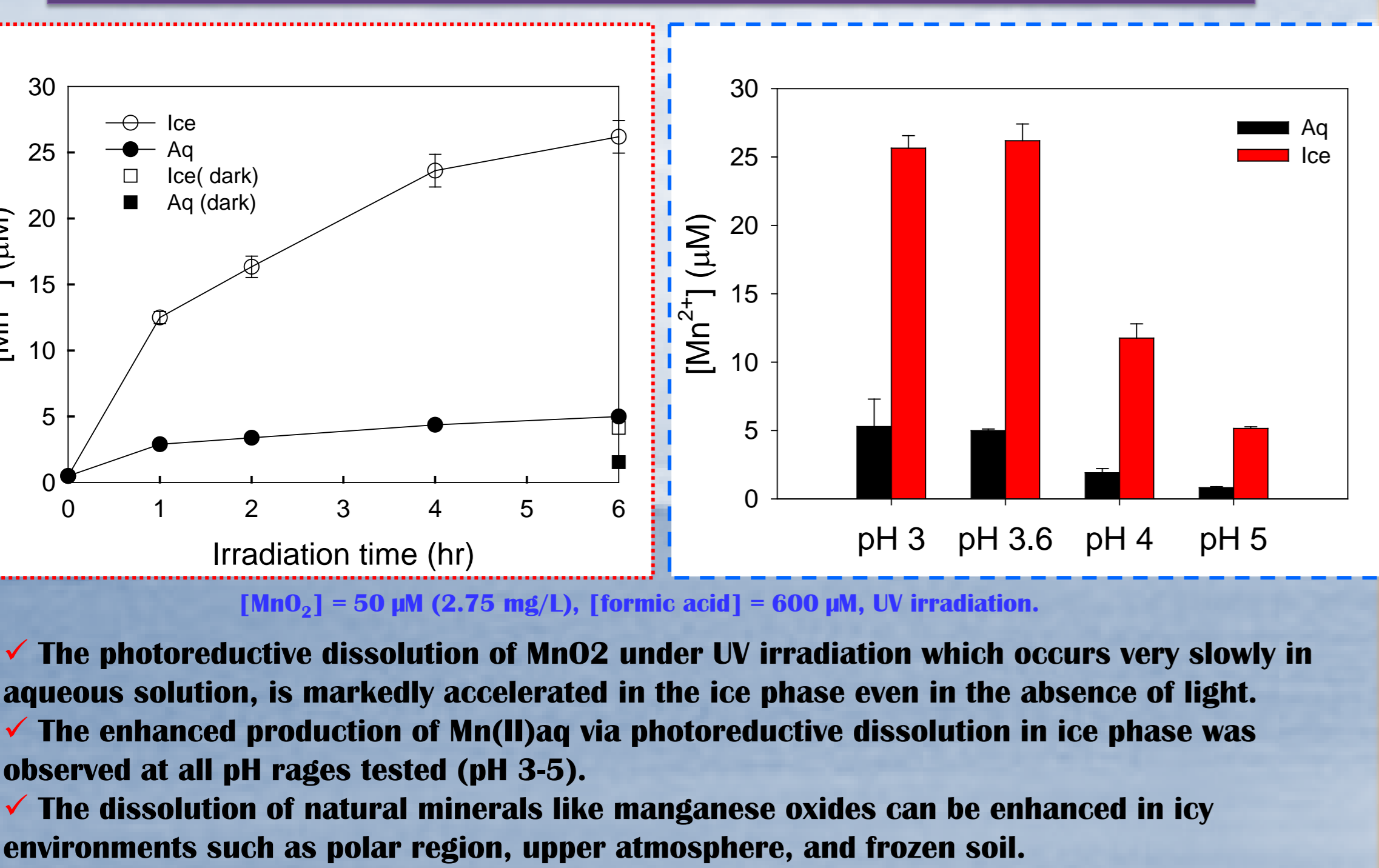
Production of Total Dissolved Iron from Iron Oxide under Dark Conditions



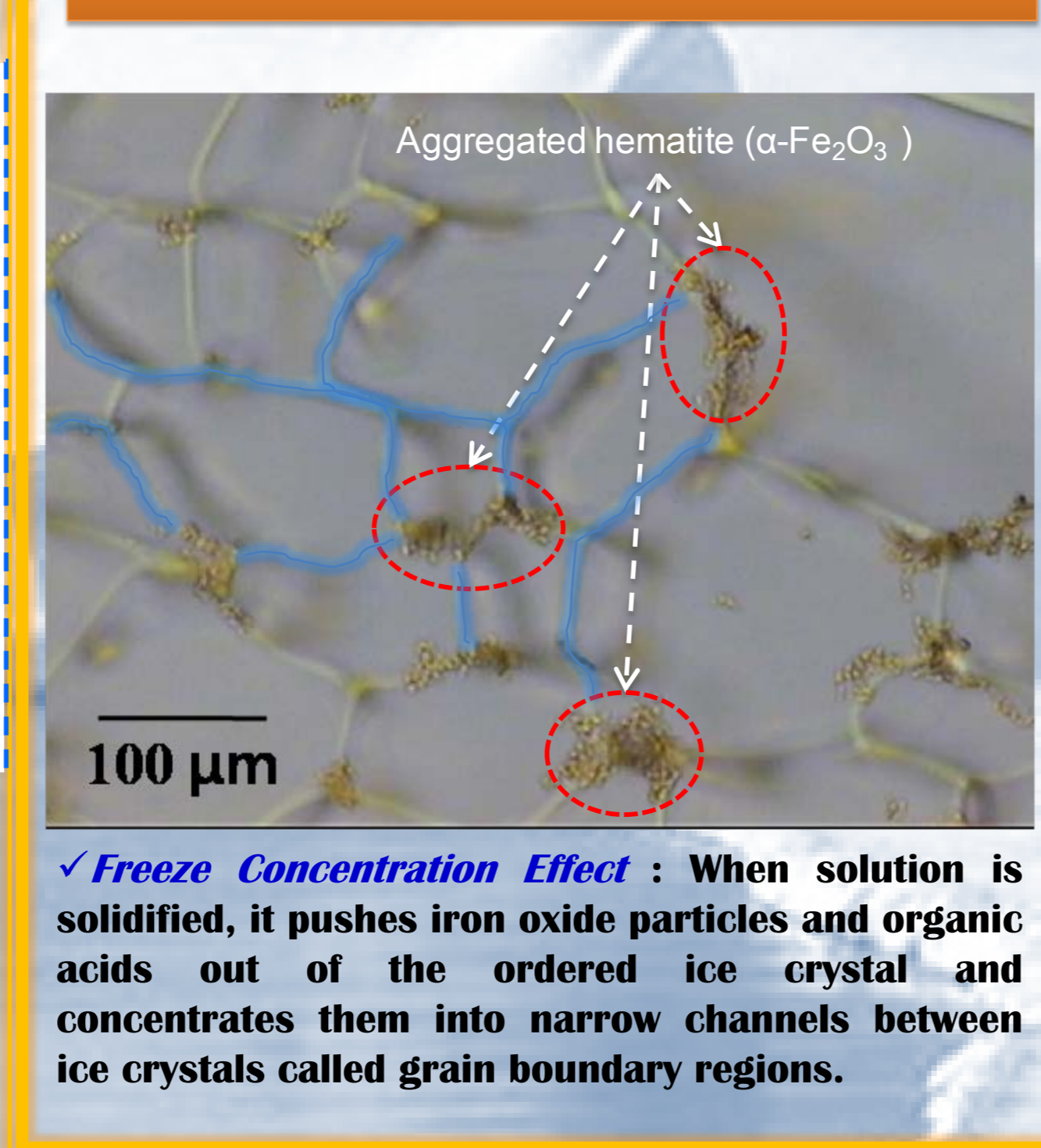
Outdoor Experiment under Solar Radiation (Ny-Ålesund, Svalbard, 78°55' N 14th - 28th May, 2009)



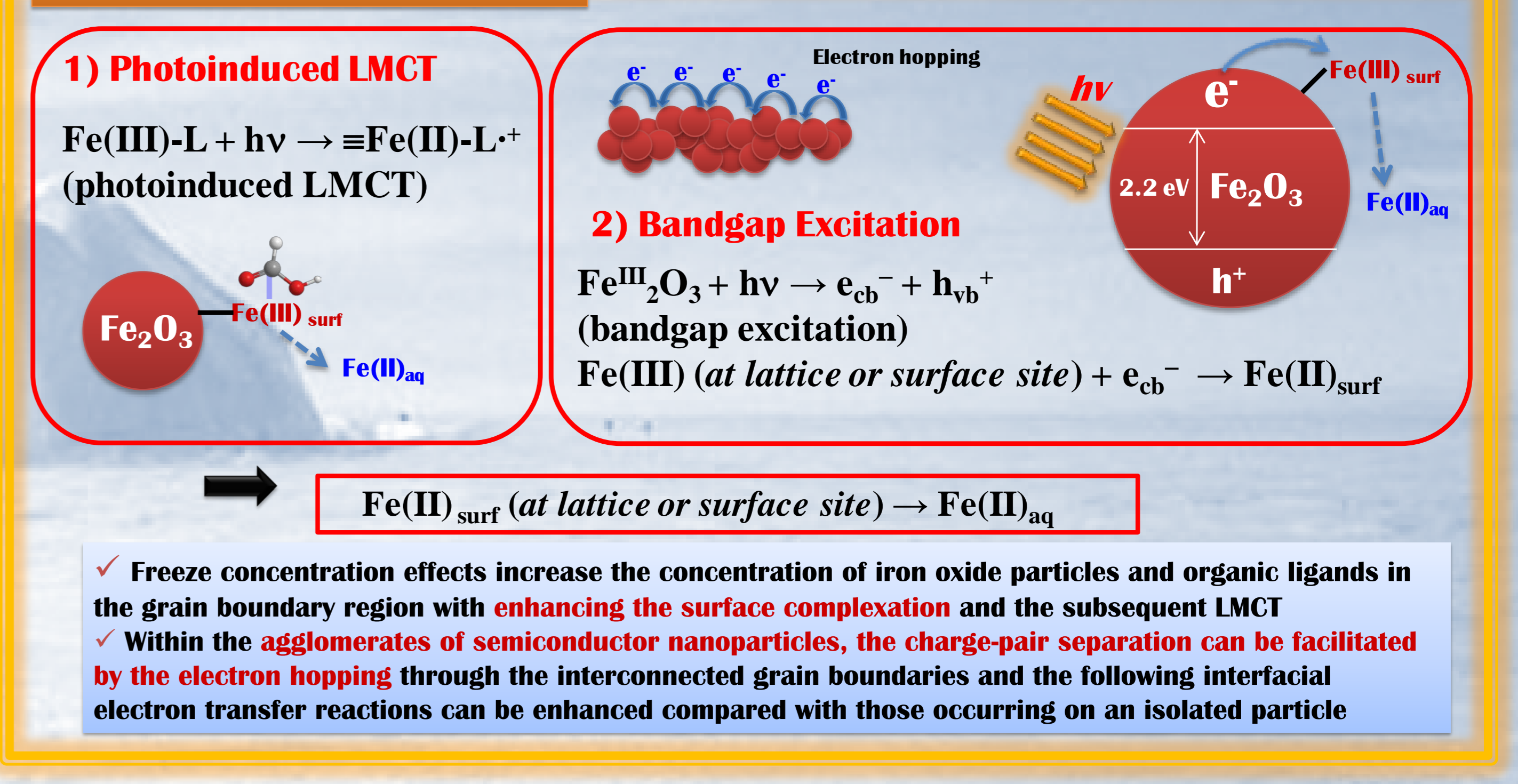
Enhanced Dissolution of Manganese Oxide in Ice under Dark and Irradiation Conditions



Freeze Concentration Effect



Proposed Mechanism



Conclusions

- ✓ The photoreductive dissolution of iron/manganese oxides proceeded slowly in aqueous solution but was significantly accelerated in ice, subsequently releasing more bioavailable iron/manganese upon thawing.
- ✓ We hypothesized that the enhanced photoreductive dissolution of iron/manganese oxides in the ice phase is not only due to freeze concentration effect but also to electron hopping through interconnected iron(manganese) oxide particles in grain boundaries facilitating the separation of photoinduced charge pairs.
- ✓ Dissolution experiments carried out with model systems under ambient solar radiation of Ny-Ålesund (Svalbard, 78°55' N) also showed that the generation of dissolved Fe(II)/Mn(II) via photoreductive dissolution is enhanced when iron/manganese oxides are trapped in ice.
- ✓ The ice(snow)-covered surfaces and ice-cloud particles containing iron(manganese)-rich mineral dusts in the polar and cold environments provide a source of bioavailable iron(manganese) when they thaw.

References

1. Kitae Kim, Wonyong Choi, Michael R. Hoffmann, Ho-Il Yoon and Byong-Kwon Park. "Photoreductive dissolution of iron oxide in ice and Its environmental Implications" *Environ. Sci. Technol.* 2010, 44, 4142-4148
- Editor's Choice, Science, Vol 328, May 28, 2010
- Chemical & Engineering News(C & EN), Latest News, May 17, 2010
2. Daun Jung, Kitae Kim and Wonyong Choi. "Enhanced dissolution of iron oxides in ice" *Atmos. Chem. Phys.*, 2012, 12, 11125-11133. (The first two authors contributed equally)
3. Kitae Kim, Ho-Il Yoon, and Wonyong Choi. "Enhanced Dissolution of Manganese Oxide in Ice Compared to Aqueous Phase under Illuminated and Dark Conditions" *Environ. Sci. Technol.* 2012, 46, 13160-13166.