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## Iron and the Great Oxygenation Event



**Figure 1 - Iron Forge**

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### Iron in History

Last week's blog entry finished with the Bronze Age collapse. Following the Bronze Age, historians generally place the beginning of the Iron Age.

One of the earliest known uses of iron was a dagger made for Pharaoh Tutankhamen and buried in his tomb <sup>1</sup>. Elsewhere in the Near East, there is evidence of experimentation with iron as early as 3,300 B.C., but it was during the period following the end of the Bronze Age in 1200 B.C. that iron production gradually developed <sup>2</sup>. By 600 B.C., the Iron Age was well underway <sup>2</sup>. Centres of early iron production include the Levant, Anatolia and Cypress <sup>2</sup>. Iron was in use in India by 1,000 B.C. <sup>3</sup> and in China, iron was being produced by 700 B.C. <sup>4</sup>. In the period between 800 and 500 B.C., iron use spread throughout Western Europe <sup>5</sup>. In North America, the Thule people, ancestors to the Inuit, are reported to have used iron from meteorites prior to 1000 A.D. <sup>6</sup>.

In modern times, iron is built into the fabric of our society. From household appliances, to steel framed buildings, to bridges, to motor vehicles, to railways and ships, iron (and its alloy, steel) is used in massive quantities by modern civilization. The use of iron, and its production, is one of the marks of the Industrial Age.

## Producing Iron

Producing iron from iron ore is essentially a process of chemical reduction whereby the iron ore, largely some form of iron oxide, is heated with a carbon source, such as coked coal, and a flux, such as limestone <sup>7</sup>. In ancient times, bog iron, an iron hydroxide concretion was commonly used as iron ore <sup>8</sup>. In modern times, most iron ore originates in banded iron formations <sup>9</sup>.

## Banded Iron Formations and the Great Oxygenation Event



**Figure 2 Banded Iron Formation, Soudan, Minnesota**

"Jaspilite banded iron formation (Soudan Iron-Formation, Neoproterozoic, ~2.722 Ga; Stuntz Bay Road outcrop, Soudan Underground State Park, Soudan, Minnesota, USA) 31" by James St. John is licensed under CC BY 2.0

The most common source of iron ore nowadays is from banded iron formations. Banded iron formations are biochemical precipitates consisting of interbedded iron rich layers and siliceous layers. Most of the banded iron formations in the world were deposited during the Great Oxygenation Event at the beginning of the Proterozoic Eon, 2,460 to 2,426 million years ago <sup>10</sup>.

The Great Oxygenation Event was a time in the history of the earth when cyanobacteria (a.k.a. blue green algae) evolved photosynthesis and began releasing free oxygen into the atmosphere

<sup>10</sup>. The basic story is that the free oxygen combined with the dissolved iron in the ocean leading to the deposition of banded iron formations.

Sounds about right, doesn't it?

The problem is in the details of the mechanism of deposition. Was the deposition biological or abiotic? Where did the iron come from? What about all that silica, how did it get there? <sup>11, 12</sup>

One of the problems is that there are no modern analogies to the late Archean, early Proterozoic environments. We are trying to understand what happened in the shift from a reducing environment to an oxidizing environment on a planetary scale. Clearly the banded iron formations record a dramatic shift in the Earth's environment, but the details are still under investigation <sup>9, 10, 11, 12</sup>.

Jelte P. Harnmeijer of the University of Washington concluded that "I can only say that the guy responsible for the cliché: "what you don't know can't hurt you" probably came up with it after a long and unhappy life spent attempting to understand Banded Iron-Formations"<sup>12</sup>.

There is a good video on YouTube from December 2020 called *How Bad Was the Great Oxygenation Event* at <https://www.youtube.com/watch?v=H476c8UjLXY> that's worth watching for an easy summary of the events of late Archean and early Proterozoic eons.

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