

**57**Fe Mössbauer spectroscopy and electrical resistivity studies on naturally occurring native iron under high pressures up to 9.1 GPa

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**ABSTRACT**

We report the pressure dependence of the Mössbauer spectra and the electrical resistivity up to 9.1 GPa at room temperature for a native iron sample collected from the Precambrian Chaibasa shales, Singhbhum Craton, Eastern India. The Mössbauer spectroscopy of the sample at ambient conditions yields isomer shifts and magnetic hyperfine field values that confirm the presence of Fe oxidation state. Many theories have been put forward to explain the origin of this native iron including a Precambrian meteoritic impact. High-pressure Mössbauer spectroscopic measurements using diamond anvil cell (DAC) showed a constant isomer shift up to 5.6 GPa with a subtle variation of $-1.07 \times 10^{-3}$ mm/s/GPa followed by sharper change $-4.3 \times 10^{-3}$ mm/s/GPa above 6.3 GPa, a pressure much lower than the usual value reported for metallic iron. Further increase of pressure to 9.1 GPa results in the emergence of a tiny peak at $-0$ isomer shift indicating the onset of the martensitic phase transition of iron from the body-centered-cubic (bcc) to hexagonal-close-packed (hcp) transition 4 GPa lower than the transition pressure normally observed for pure iron. This phase transition in the native iron is confirmed by high-pressure electrical resistivity study. Lowering of the transition pressure could be due to nucleation of hcp by stacking faults caused by shock metamorphism resulting from the Precambrian impact in the region.

**Keywords:** Mössbauer spectroscopy, high pressure, diamond anvil cell, native iron, Precambrian impact, electrical resistivity, XPS spectroscopy

**INTRODUCTION**

Mössbauer spectroscopic studies of iron and its high-pressure polymorphs, important constituents of meteorites and other terrestrial and extra-terrestrial objects, provide important information about their origin and pre-terrestrial transformations. Since the discovery of up to 25 tons heavy boulders of native iron on Disko Island, West Greenland, this occurrence has attracted much attention. The origin of native iron has been the subject of much speculation and various theories have been proposed ranging from meteoroid impact to the chemical reaction between magma and carbonaceous sediments (Carpenter 1935; Cameron 1970; Gibb et al. 1970; Kukkonen et al. 1992; Collinson 1990; Abbott et al. 2006; Colwell et al. 2007; Haggerty and Toft 1985). However, only two preliminary reports are published on the possible occurrence of native iron in India: The first study based on the magnetic properties of the sample, the second report characterized the sample with magnetic susceptibility and scanning electron microscopy (SEM) measurements. These findings suggested the occurrence of native iron in the Precambrian Chaibasa shales to be the oldest native iron ever found, formed due to the pre-1.6 Ga impact and preserved for over 1.6 billion years by sudden burial of the molten iron and fast sedimentation in the region. The iron melted during the nearby impact event,

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