DESCRIPTIVE MODEL OF OOLITIC IRONSTONES

By J.B. Maynard[1] and F.B. Van Houten[2]

BRIEF DESCRIPTION

SYNONYM: Clinton-type deposit, Minette-type deposit.
DESCRIPTION: Beds rich in iron silicate and oxide minerals with distinctive oolitic texture deposited in shallow-shelf to intertidal, clastic-dominated environments.
TYPICAL DEPOSITS: Wabana, Newfoundland (Ranger and others, 1984); Birmingham, Alabama (Simpson and Gray, 1968); Lorraine, France and Luxembourg (Teyssen, 1984); southern Algeria (Guerrak, 1987); Cleveland, northeast England (Hallimond, 1925); Northampton Sand, England (Taylor, 1949).
RELATIVE IMPORTANCE: Important source of Fe from 1850 to 1945. Declining world importance since then because of competition from Precambrian banded-iron formations.
DISTINGUISHING FEATURES: Distinguished from banded-iron formations by absence of chert, presence of oolitic textures, and Al-bearing silicates. Distinguished from blackband ironstones by absence of primary siderite and presence of oolitic textures.
COMMODITIES: Fe.
OTHER COMMODITIES: Ocher.
ASSOCIATED DEPOSIT TYPES (*suspected to be genetically related): None.

REGIONAL GEOLOGIC ATTRIBUTES

TECTONOSTRATIGRAPHIC SETTING: Craton margins, 40 percent; craton interiors, 25 percent; foreland basins, 20 percent; exotic terranes, 15 percent.
REGIONAL DEPOSITIONAL ENVIRONMENT: Shallow shelf, most typically close to the transition from nonmarine to marine environments.
AGE RANGE: Phanerozoic, concentrated in the Ordovician to Devonian and Jurassic to Paleogene. A few Proterozoic examples.

LOCAL GEOLOGIC ATTRIBUTES

HOST ROCKS: Almost always clastic hosted at top of coarsening and shoaling-upward cycles (fig. 24).
ASSOCIATED ROCKS: Standard vertical succession is black shale at base, followed by gray shale and siltstone, then by sandstone with graded bedding and hummocky cross-stratificiation suggesting tempestites, and finally by sandstone or oolitic ironstone with bipolar cross-stratification suggesting intertidal deposition. The association with black shale (Hallam and Bradshaw, 1979) is significant: 75 percent of well-developed Phanerozoic ironstones have an extensive black shale at the base of the shoaling cycle (Van Houten and Arthur, 1989).
ORE MINERALOGY: Younger rocks: goethite + berthierine (7-Å chlorite). Older rocks: hematite + chamosite (14-Å chlorite). Siderite common as a replacement; locally, pyrite found as replacement (Maynard, 1986); occasionally, magnetite.
GANGUE MINERALS: Quartz ± calcite ± dolomite ± clay minerals; apatite (collophane) ubiquitous in small amounts.
STRUCTURE AND ZONING: Rarely reported. Hematite cemented with Fe silicates to magnetite at Sierra Grande, Argentina (Leiding V., 1955).
ORE CONTROLS: Three-quarters of deposits show strong control by position at the top of sedimentary cycle. Many of the larger deposits show features of tidally influenced deposition.

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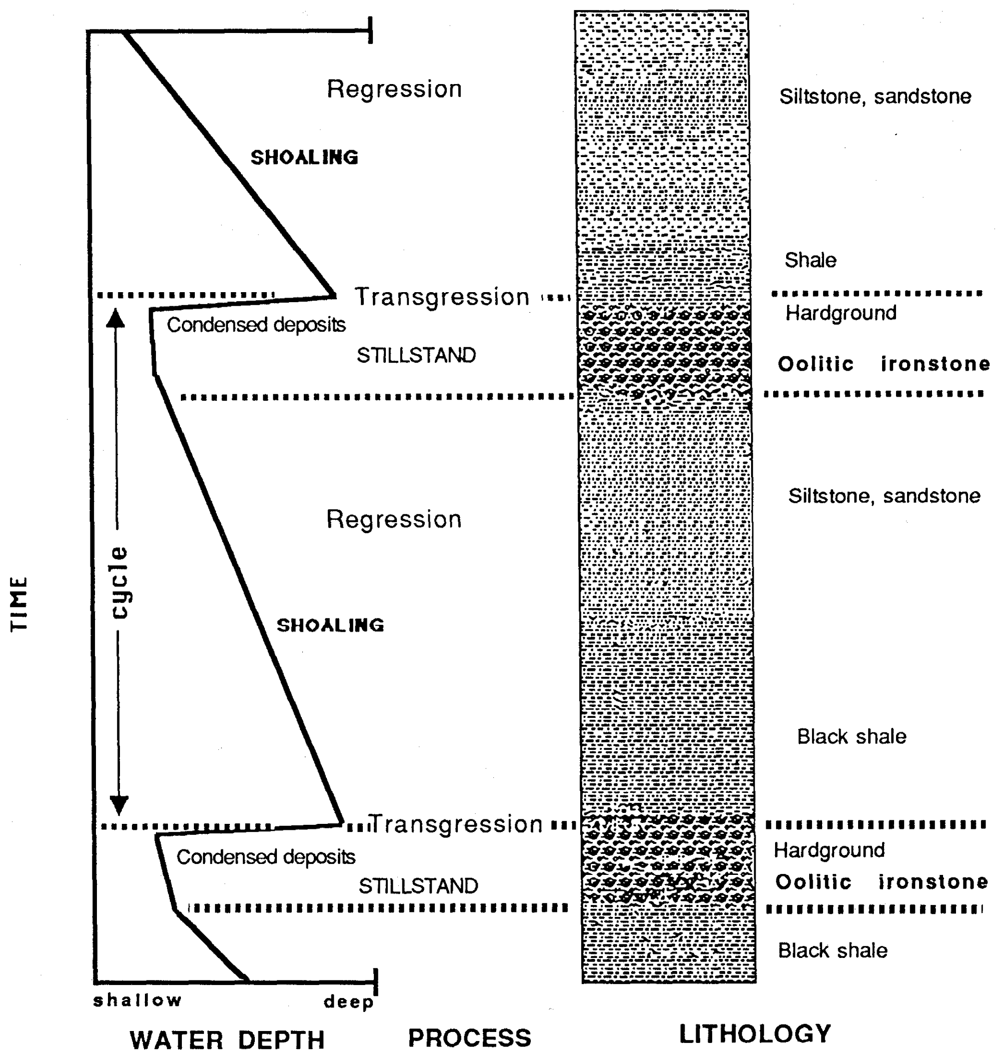

Figure 24. Generalized stratigraphic model for oolitic ironstones. Vertical scale is variable; cycles may range from a few meters to as many as 300 m in thickness (modified after Van Houten and Bhattacharyya, 1982; Maynard, 1983).

ISOTOPIC SIGNATURES: Siderite has light C, about –18 per mil; unknown for other minerals (Maynard, 1983).

STRUCTURAL SETTING: Major deposits in undeformed to simply folded strata. Some Ordovician deposits on blocks complexly deformed by the Armorican (Hercynian) orogeny of Western Europe.

ORE DEPOSIT GEOMETRY: Tabular bodies 2 to 5 m thick and 2 to 10 km across.

ALTERATION: None relevant to mineralization.

EFFECT OF WEATHERING: Removes carbonate gangue and converts ferrous silicates to ferric oxides. Many older mining operations based on weathered ore; typically, workings less than 30 m into outcrops.

EFFECT OF METAMORPHISM: Goethite converts to hematite above 80 °C (Hodych and others, 1984); hematite converts to magnetite under metamorphic conditions, but a few apparently unmetamorphosed deposits have magnetite (Devonian deposits of Libya). Berthierine converts to chamosite at 130–160 °C (Iijima and Matsumoto, 1982). Most deposits unmetamorphosed.

GEOCHEMICAL SIGNATURES: Only Fe.

GEOPHYSICAL SIGNATURES: Marked positive gravity anomaly (1 mgal over 1–5 km) useful in delineating orebodies (Miller, 1983). Magnetite-bearing occurrences detectable by airborne magnetometer.

OVERBURDEN: Most commonly clastic sedimentary rocks, from 0 to 500 m in recently active mines.

GRADE AND TONNAGE MODEL OF OOLITIC IRONSTONES

By Greta J. Orris

COMMENTS As with many deposit models, grade-tonnage information was not available for some of the well-known deposits. In addition, deposit definition (especially with regard to size information) is complicated by (1) the areally extensive bedded nature of the deposits, (2) the presence of multiple mineralized layers interbedded with country rock, and (3) the ambiguity of the reporting with regard to mining district or individual mine- or deposit-level information. Some deposits and (or) mines had tonnages or grades that were so disparate from the tentative grade-tonnage models that they could not be considered. This type of problem is often due to reporting error or deposit definition error. Several tonnages reported for English deposits were orders of magnitude too low and might represent reserves of mines working only parts of larger deposits, and some U.S. and French deposits had tonnages so large that it is likely that several deposits were composited into single grade and tonnage figures. Lastly, it is impossible to claim that all possible sources of information were found and consulted. See appendix B for locality abbreviations. See introduction for explanation of the grade and tonnage model as shown in figures 25–28.

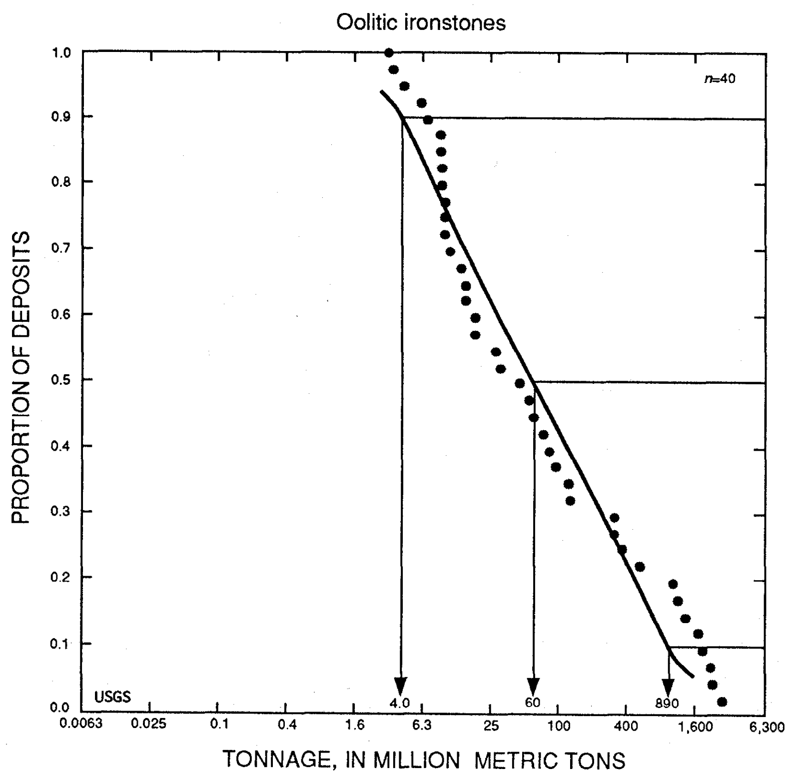

Figure 25. Tonnages of oolitic ironstone deposits.

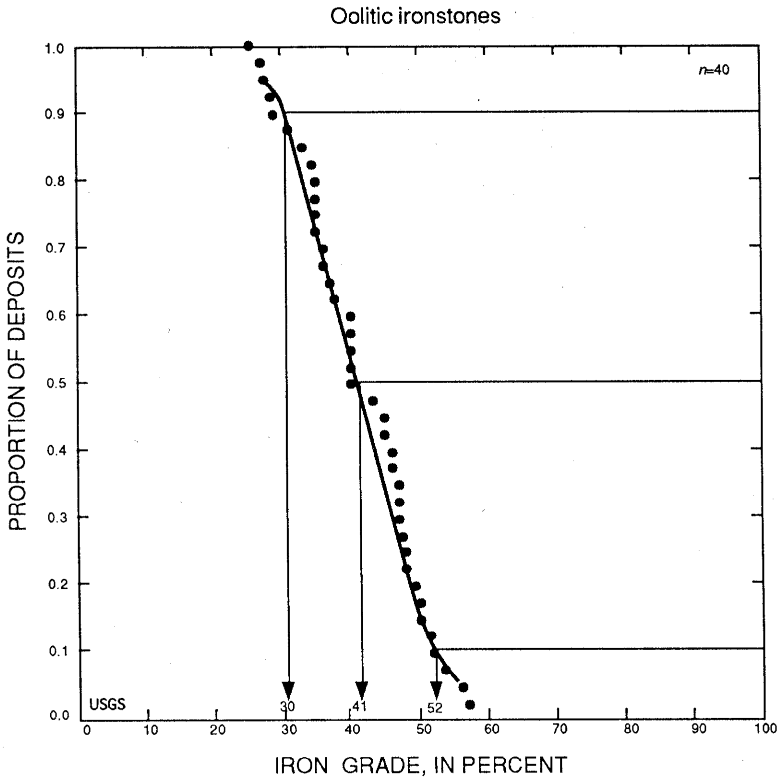

Figure 26. Iron grades of oolitic ironstone deposits.

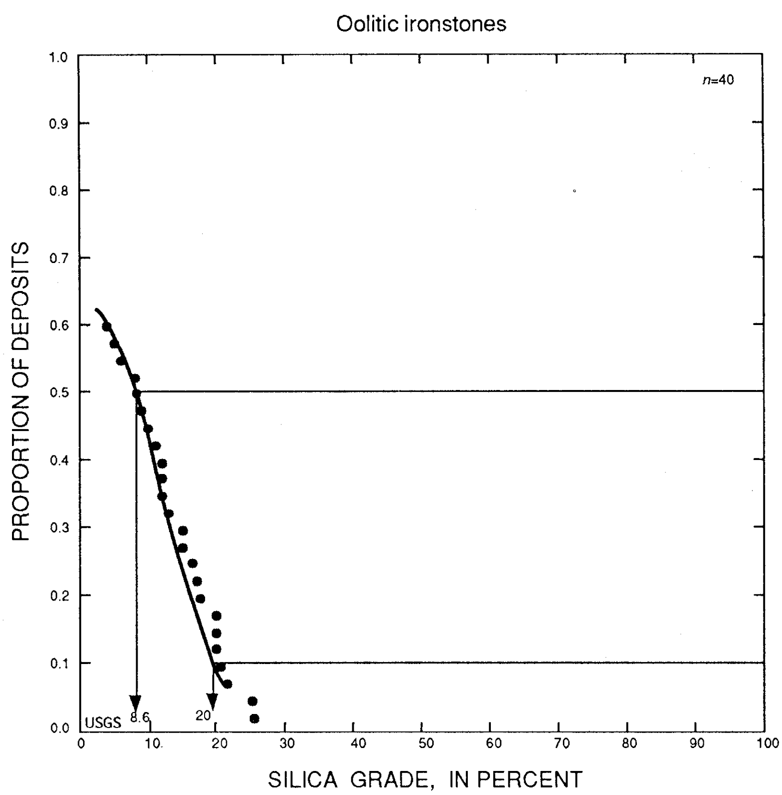

Figure 27. Silica grades of oolitic ironstone deposits.

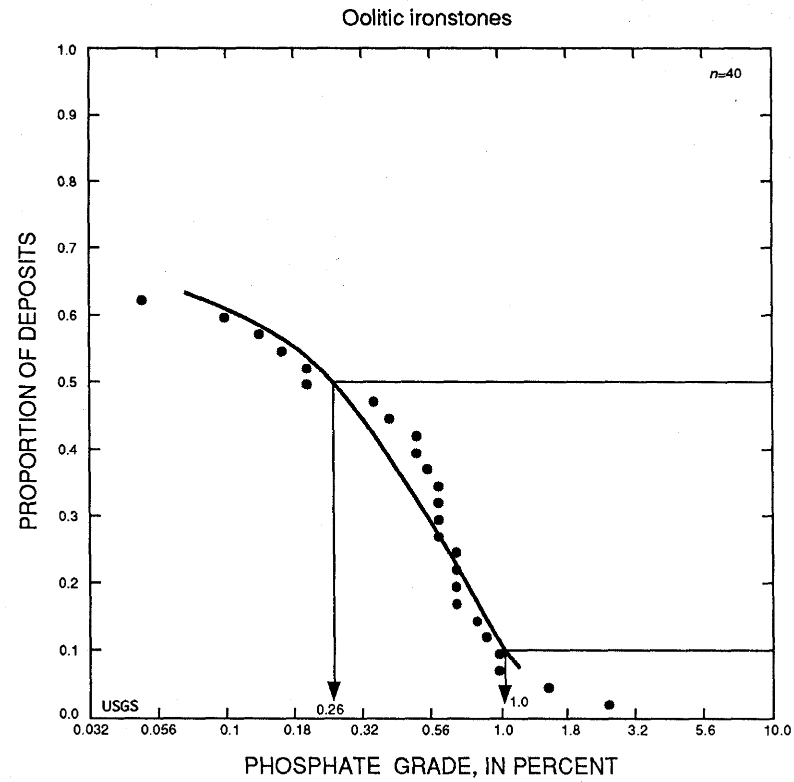

Figure 28. Phosphate grades of oolitic ironstone deposits.

DEPOSITS

Name	Country
Ait Amar	MRCO
Aswan	EGPT
Birmingham	USAL
Boulhaut	MRCO
Camdag	TRKY
Cho-lu	CINA
Cleveland	UKEN
Couthuin	BLGM
Demir Hisar	YUGO
Frodingham-Scunthorpe	UKEN
Gara Djebilet–Central area	ALGR
Gara Djebilet–East area	ALGR
Gara Djebilet–West area	ALGR
Holoubkha	CZCL
Hsin-yao	CINA
Imi n'Tourza	MRCO
Isle of Raasay	UKSC
Jebel Ank	TUNS
Kerch	USSR
L'Hermitage-Lorge	FRNC

DEPOSITS

Name	Country
Langrial	PKTN
Ljubija	YUGO
Ma-yu-kou	CINA
Moncorvo	PORT
Musson-Halanzy	BLGM
Nucice	CZCL
Nurra	ITLY
Ouarzemine	MRCO
Pang-chia-pu	CINA
Paz del Rio	CLBA
Salzgitter	GRMY
San-cha-kou	CINA
Settat	MRCO
Sierra Grande	AGTN
Sui-Ning	CINA
Sumadija	YUGO
Tajmiste	YUGO
Wabana	CNNF
Yen-tung-shan	CINA
Zditz	CZCL