# AN EXTENSIVE DATA BASE FOR COBALT-RICH FERROMANGANESE CRUSTS FROM THE WORLD OCEANS

Frank T. Manheim, Timothy H. Ling, and Candice M. Lane
U.S. Geological Survey, Woods Hole, MA 02543

## Abstract

A new database for ferromanganese crusts from the world oceans is being compiled by the U.S. Geological Survey. Crusts differ from abyssal nodules by forming principally on steeper, raised areas or current-swept plateaus in the oceans. Some crusts contain relatively large concentrations of cobalt (1.0%) in areas within national territorial jurisdictions.

---

Recent studies suggest that cobalt-rich ferromanganese crusts on the ocean floor may have economic potential[1,2,3,4,5]. Because some crust sites are within 200 nautical miles of the United States, they fall within national jurisdiction. With the assistance of the U.S. Bureau of Mines and major repositories of oceanographic data, the U.S. Geological Survey has begun a search for all available data on ferromanganese crust occurrences in the world oceans and will incorporate these data into a computer-accessible data file.

Ferromanganese crusts on the sea floor are generally found in association with environmental characteristics that are different from those in nodule areas. Crusts tend to occur on consolidated rock surfaces in raised areas of the sea floor that are too steep for permanent sediment accumulation (Fig. 1), and/or that are swept free of sediment by strong, permanent or episodic currents. Except in sites where hydrothermal sources of metals are present, such as the East Pacific Rise and associated fracture zones, the crusts tend to form at rates equivalent to the slowest accumulation rates of ferromanganese oxides in the ocean. Consequently, the oldest substrates have the thickest crust accumulations. For example, both Mid-Pacific Mountains and New England Seamount crusts may be as thick as 10 cm on substrates ranging to Cretaceous in age. In the absence of hydrothermal emanations, recently formed midocean ridge sites tend to have only very thin crust accumulations. Wide areas of the Blake Plateau off South Carolina have very low slopes and unusually shallow depths (800 m) for crust formation. However, here the Gulf Stream has maintained a sediment-free environment since middle Tertiary time, and crust pavements as thick as 8 cm have been formed by a combination of accretion and replacement of phosphorite substrates[6] (Fig. 2).

Cobalt, manganese, nickel, vanadium, molybdenum, and platinum appear to be the most valuable metals in ferromanganese crusts. The metal content of crusts is apparently more critically influenced by metal sources in ambient water than is metal content in abyssal manganese nodules. Hence, the data base will include samples that have only very thin ferromanganese layers, in order to broaden geographic representation and provide data on crusts from a range of water depths. Many seamount and ocean island crusts are formed on phosphorite substrates. Although the phosphorite alone would not be an economically feasible resource, if crusts become a target for economic recovery, processing of phosphorites might become an adjunct to waste disposal.

In a preliminary review of the Scripps Institution manganese nodule data base[7], chemical data were associated with 639 "crust" samples (Fig. 3). Several hundred additional crust specimens and data on a total of 654 stations from eight institutions are now being processed (Table 1, Fig. 3). Field visits to the Lamont Geological Observatory, Palisades, N.Y.; Department of Oceanography, University of Washington, Seattle, Wash.; School of Oceanography, Oregon State University, Corvallis, Ore.; Dept. of Geological Sciences, University of British Columbia, Vancouver, B.C.; Graduate School of Oceanography, University of Rhode Island, Narragansett, R.I.; Institute of Marine Science, University of Alaska, Fairbanks, Alaska, and the U.S. Naval Oceanographic Research facilities in Bay St. Louis, Miss., are scheduled or planned.

The new data base will include standard background data coverage like that utilized in the Scripps Institution nodule data base[7], as well as new parameters appropriate to the present survey and user-interactive capabilities. The new samples are being chemically analyzed by U.S. Geological Survey and other cooperating laboratories.

The data base will contain information on crusts of all types. Crusts having high cobalt content (more than 1%), have been found to date primarily in the Pacific Ocean, but are also known to be present in the Atlantic and Indian Oceans. In addition, the database should yield new scientific insights into the metal content of the oceans, present and past, and the pathways for migration and removal of metals in the oceanic enviroment.

Table 1. Samples collected as of Aug. 1, 1983. Data on these samples will form the basis of the data file on ferromanganese crusts. WHOI: Woods Hole Oceanographic Institution, Woods Hole, Mass.; U. Miami: Rosenstiel School of Marine and Atmospheric Sciences, Univ. Miami, Miami, Fla.; Scripps: Scripps Institution of Oceanography, University of California, San Diego Calif.; USC: Dept. of Geological Sciences, University of Southern California, Los Angeles Calif.; FSU: Dept. of Oceanography, Florida State University, Tallahassee, Fla.; NOAA, National Oceanic and Atmospheric Administration, Blake Plateau collection on permanent loan to Smithsonian Inst. (see below); Smithsonian: Smithsonian Institution, Dept. of Mineral Sciences, Washington, D.C.; Hawaii, University of Hawaii, Dept. of Oceanography and Hawaii Institute of Geophysics, Manoa, Oahu, Hawaii.

| Inst. | No. cruises | No. of sta. with crusts sampled | No. of sta. with other data | No. sta. Total |
|---|---|---|---|---|
| WHOI | 18 | 51 | 20 | 71 |
| U. Miami | 8 | 21 | - | 21 |
| Scripps | 30 | 156 | 92 | 248 |
| USC | 3-4 | 5 | 20 | 25 |
| FSU | 19 | 66 | 2 | 68 |
| NOAA | ? | 22 | - | 22 |
| Smiths | ? | 19 | - | 19 |
| Hawaii* | 10 | 120 | 60 | 180 |
| Total | 89 | 460 | 194 | 654 |

*Numbers approximate, records being processed.

Figure 1. See next page for text.

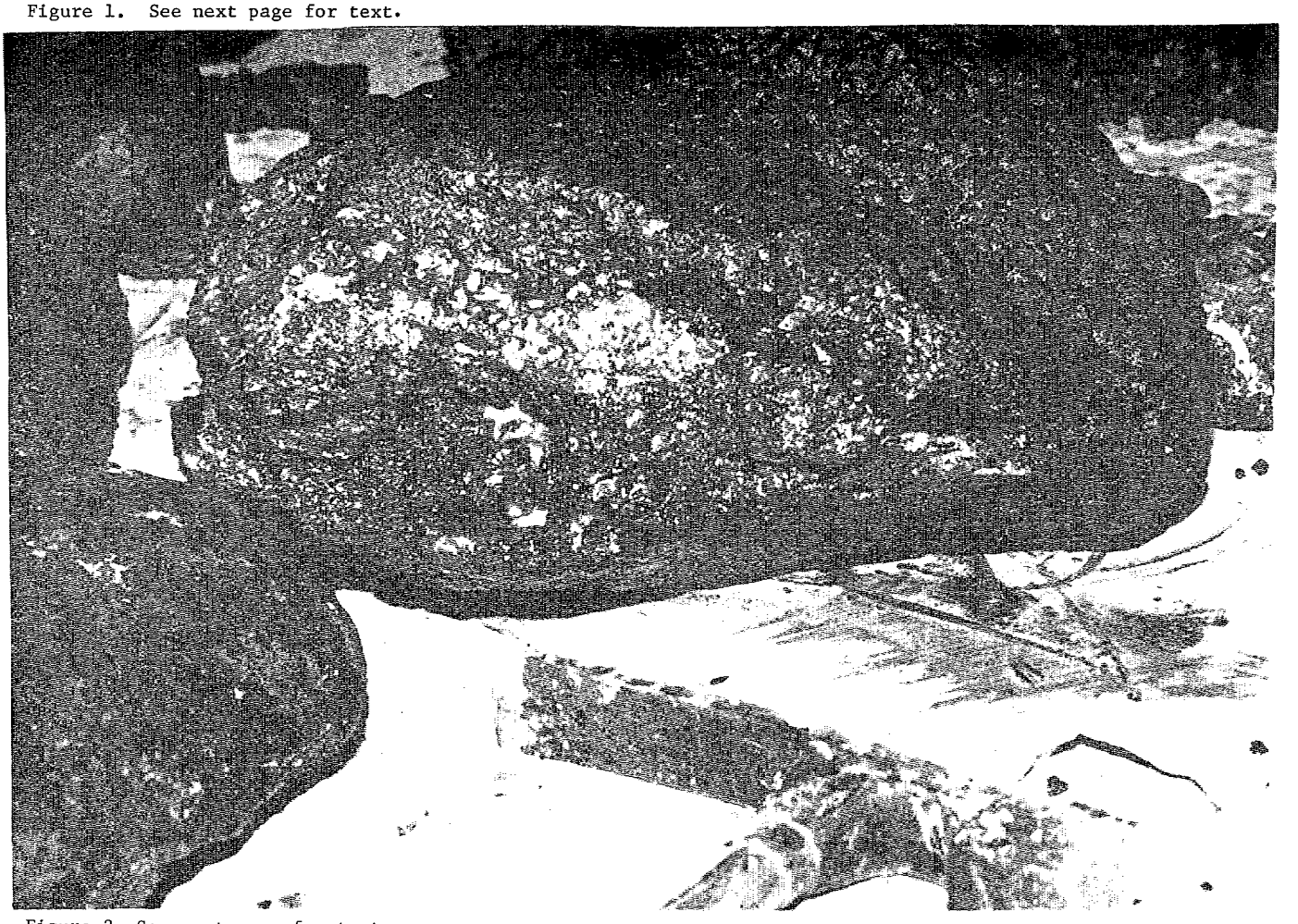

Figure 2. See next page for text.

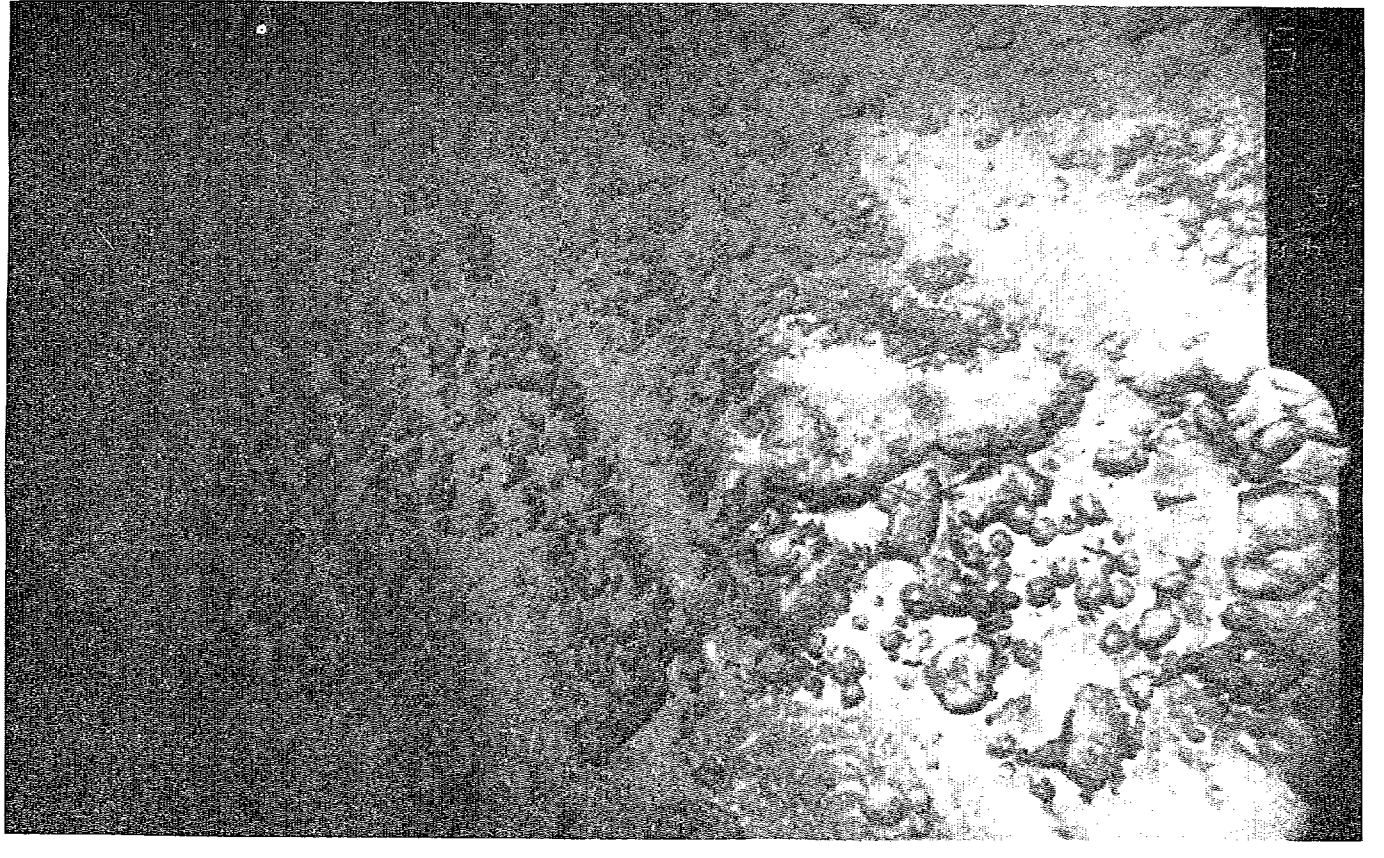

Figure 1. Typical ferromanganese crust on altered basalt boulders from Mid-Pacific Mountain area[2]. Station DK 73, loc. 19°24.09'N., 171°10.37W., 2,856 m.

Figure 2. Outcropping ferromanganese pavement with manganese nodule field on Blake Plateau at 800 m water depth. Visual field covers about 15 m; photo by Angus wide-angle camera system on U.S. Geological Survey cruise on R/V Gyre 11, Sept. 1982.

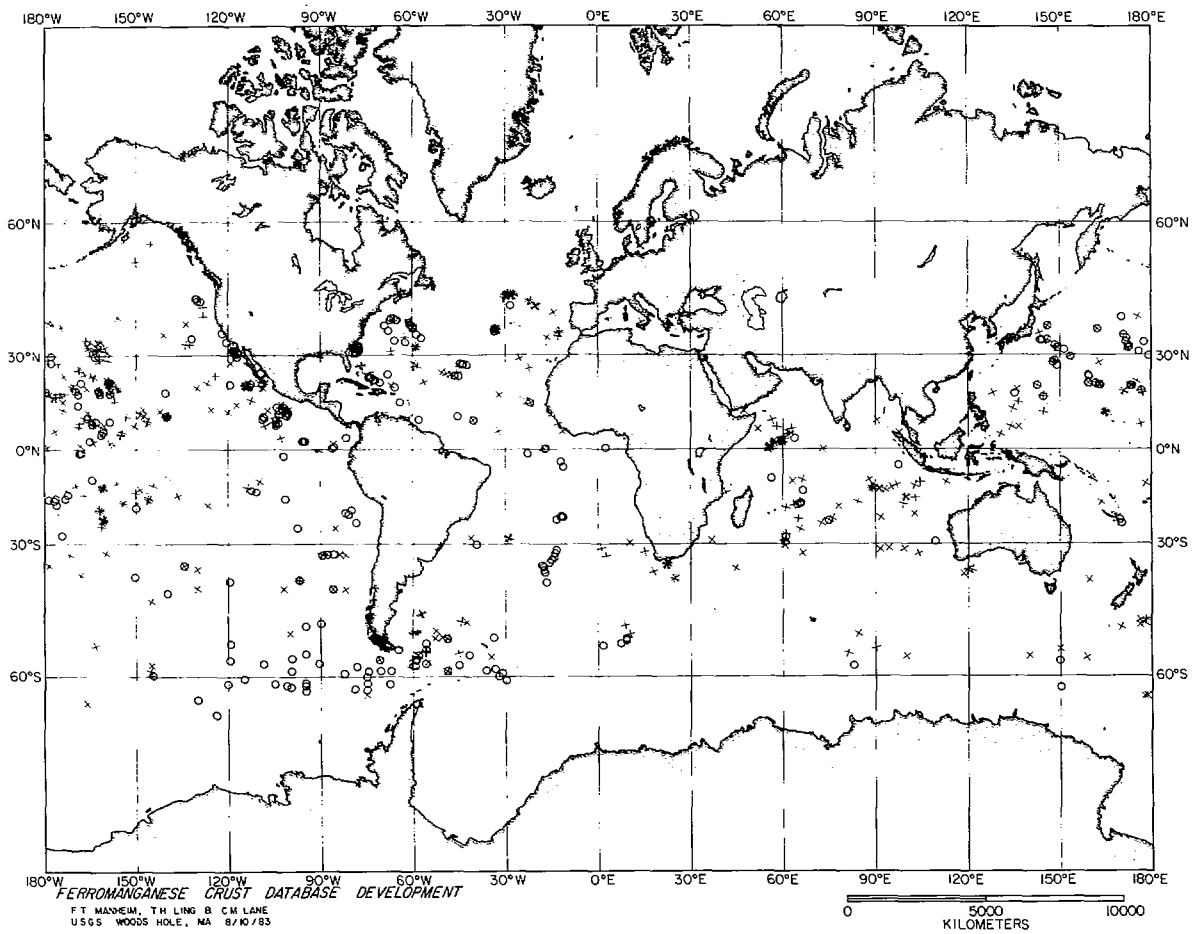


Figure 3. Locations where ferromanganese crust samples have been collected; data on these samples will be entered in the new data base. X marks sites of samples for which analyses have come from the Scripps Institution manganese nodule data base[7]; O marks sites of newly collected specimens enumerated in Table 1.

References


1. Halbach, P., Manheim, F.T., and Otten, P., 1982. Co-rich ferromanganese deposits in the marginal seamount regions of the Central Pacific Basin - results of the Midpac '81. Erzmetall. v. 35, p. 447-453.

2. Halbach, P., 1982, Co-rich ferromanganese seamount deposits of the Central Pacific Basin, in Halbach, P., and Winter, P. (eds.), 1982. Marine Mineral Deposits - New Research Results and Economic Prospects. Marine Rohstoffe und Meerestechnik, Bd 6, Verlag Gluckauf Essen, p. 60-85.

3. Manheim, F.T., Halbach, P., Woo, C.C., and Commeau, R.F., 1982. Economic significance of ferromanganese crusts on seamounts of the Mid-Pacific area. Geol. Soc. America Abs. with Programs, v. 14, p. 555.

4. Halbach, P., and Manheim, F.T., 1983. Cobalt and other metal potential of ferromanganese crusts on seamounts of the Central Pacific Basin: results of the Midpac-81 Expedition. Marine Mining (in press).

5. Halbach, P. and Puteanus, D., Metal fluxes in ferromanganese crusts in the Pacific Ocean. Nature, in press.

6. Manheim, F.T., Popenoe, P., Siapno, W., and Lane, C., 1982, Manganese - phosphorite deposits of the Blake Plateau, in Halbach, P., and Winter, P. (eds.), Marine Mineral Deposits, New Research Results and Economic Prospects. Marine Rohstoffe und Meerestechnik, Verlag Glückauf, Essen, p. 9-44.

7. Frazer, J.Z., and Fisk, M.B., 1980. Geological factors related to characteristics of seafloor manganese nodule deposits. Scripps Institution Reference 79-19, 41 p.