

# TECHNICAL NOTE:

## Landsat Application To Nautical Charting

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The author is neither a hydrographer nor nautical chart maker. His interest in using Landsat imagery for nautical charting stems from his job as Cartography Coordinator for the EROS Program of the United States Geological Survey (USGS) during the 1970s and 80s. In scope it is limited to the chart named CHAGOS ARCHIPELAGO (61610), as published by the US Defense Mapping Agency (DMA) at a scale of about 1:360,000 on the Mercator projection. Moreover, only three editions of this chart were examined as follows: Second Edition of Feb. 21, 1976 Third Edition of Aug. 28, 1976 Sixth Edition of Aug. 31, 1991

The Second Edition was based on an Indian (British) survey of 1837 with navigational aids and hazards corrected through 1975. This edition contains extensive delineation of the numerous reefs in the area, and a large number of soundings. The Third Edition was published barely six months after the Second Edition. This is very significant when one considers the time and expense involved in revising and publishing a new edi-

tion. The reason for the early revision becomes apparent upon examination of the two editions. During March and April, 1976, at the suggestion of the author and others, Landsat 2 was put into a "high gain" mode over certain shallow sea areas selected by DMA. This procedure amplifies the signal from low response features such as shallow water bottoms. The results were spectacular. A sizable reef of 8 kilometer length and about 10 meter depth, which had not been charted, was clearly defined on the Landsat imagery. However, the most significant feature of the imagery was that many of the reefs in the area were mislocated by several kilometers; and one, "Ganges Bank", by 13 kilometers. The Third Edition of this chart showed the newly discovered reef (named Colvocoresses) and "corrected" the numerous mislocated reefs, although their previously reported positions (outlines) were still shown as "Doubtful". Not only was precise positioning of shallow sea features in such an area clearly demonstrated, but the capability for providing depth information of such features was also

verified. The smallest response element on Landsat 2 was the 80m picture element pixel) so it obviously could not record bottom conditions which were not at least that large. The depth of Colvocoresses Reef (which is quite flat) was estimated to be 10m. This estimate was based on comparing the bottom response of the reef to that of other underwater features in the area of known depth and whose response of the bottom (coral) was expected to be similar to that of the reef. However, based on a subsequent ship survey and safety considerations DMA recorded 9m as the reef's minimum depth on later chart editions. Based on the Chagos, and other shallow sea experiments, DMA requested that NASA obtain high-gain Landsat data over most of the shallow seas of the Earth during 1978.

The Sixth Edition of Chagos (1991) appears to have the numerous and sizable corrections made on the Third Edition. It also includes an "Omega" grid and other refinements.

In 1977, James Hammack of DMA published "Landsat Goes to Sea", describing what

satellites were promising the nautical chart makers. Now, 20 years later it is time to revisit Landsat's impact on this field. In March, 1995, the National Imagery and Mapping Agency (NIMA) published and distributed a brochure on this subject which is also in their Internet homepage, but an in-depth report on this matter appears warranted.

With modern positional systems such as the GPS, there is little reason for a ship's position not being known to within 100m. Obviously if available charts contain positional errors several times this distance, the chart loses much of its value. Based on U.S. map accuracy standards, a properly made map (or chart) should have a high (90%) probability of being accurate to within 1/50 of an inch (0.5mm). At the 1/360,000 scale of the Chagos chart, this is equal to 183m. Nautical charts, for a variety of reasons, may not meet this standard. However, a satellite which incorporates the geometric and radiometric characteristics of Landsat is an essential tool for those who would map the world's shallow seas.