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## AN OCEANOGRAPHIC GRID SYSTEM FOR COASTAL AND CONTINENTAL MARGIN AREAS (\*)

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—In the Marsden Square Grid System, or its derivations — and this is the system that most national and international oceanographic data acquisition centres employ — the information is located geographically for statistical purposes by means of a grid consisting of  $10^\circ$ ,  $5^\circ$  or  $1^\circ$  "squares". The system, an early one dating from 1850, has three major disadvantages, and this has meant that its numbering principle cannot be used for a grid whose smallest lattice is less than  $1^\circ$  of latitude by  $1^\circ$  of longitude.—

The first drawback is the numbering system itself. Beyond latitudes  $10^\circ$  N and  $10^\circ$  S it becomes impossible to know as to what sector of the globe a given number refers without recourse to a chart or to a table giving conversions into geographical coordinates.

The second drawback is linked to the first, and concerns electronic data processing techniques. The use of a Marsden Square number for indicating geographic coordinates on a flatbed plotter necessitates either a numerical sub-program or a program stored in memory.

The third drawback of the Marsden system is that four figures are necessary in order to determine a quadrilateral of  $5^\circ \times 5^\circ$  and five figures for one of  $1^\circ \times 1^\circ$ . The Marsden system was not designed to go beyond this limit.

In order to mitigate some of these drawbacks BAUDIN-LAURENCIN (1966) devised an improved Marsden Square numbering system using the same number of figures. Its great improvement lies in the fact that it permits conversion of code to position from information given by a three or a five figure number. Once again, the system's limits were purposely set at  $1^\circ \times 1^\circ$  quadrilaterals.

However, a surface of  $1^\circ$  latitude by  $1^\circ$  longitude is an area too vast for use in connection with the collection and processing of data required for hydrological, sedimentological, bionomic and fisheries studies in coastal regions. For more precision we must be able to go as far as minutes of latitude and longitude.

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### **I. — PURPOSE, AND ADVANTAGES**

The problem of locating data geographically is a particularly difficult one when the data are submitted by the many different workers in the marine field (for instance, fishermen, or other workers — to employ the word in its widest sense).

These difficulties are of two kinds. Firstly, the fisherman or the collector in general who has to give a position may not wish to do so with too much precision (he may wish to protect his personal fishery grounds, or to ensure that industrially exploitable mineral deposits are protected.) Secondly, he may be beset by practical difficulties of accurate geographic positioning.

It was, therefore, necessary to devise a numbering system with the following characteristics :

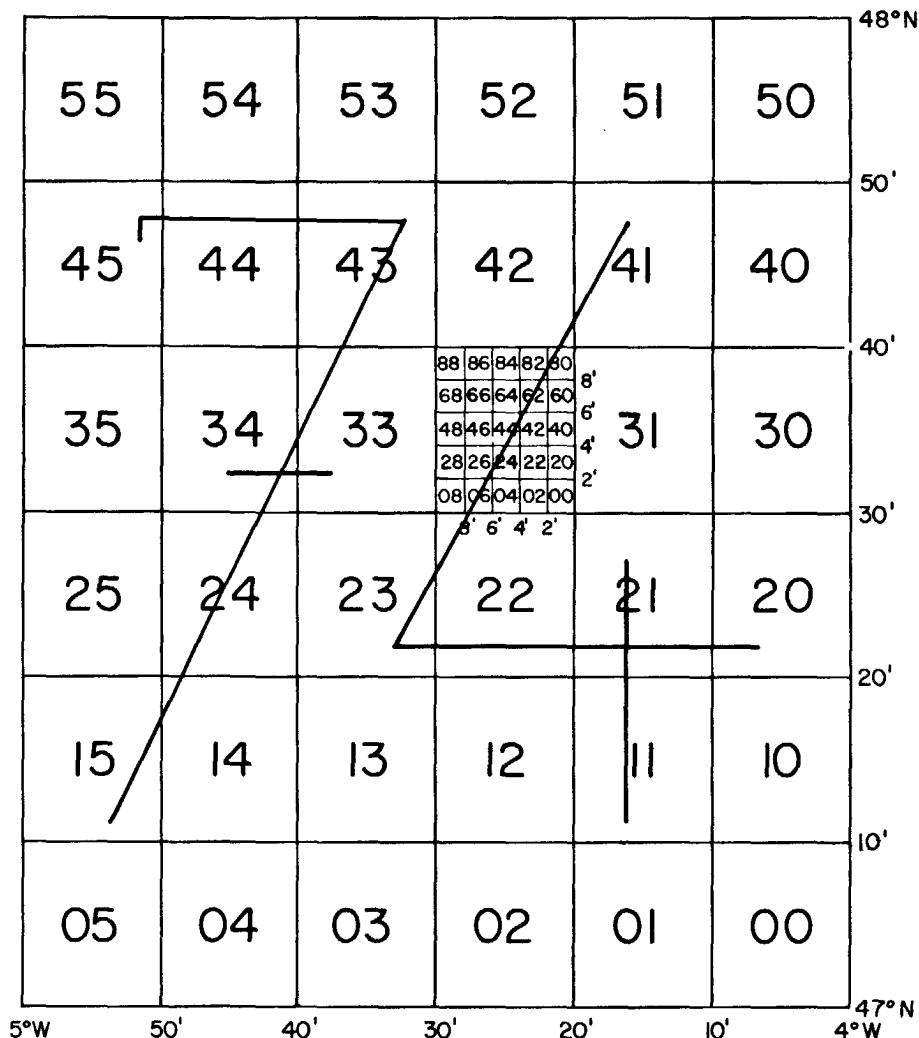
- Provide a degree of precision of as much as a minute of latitude and longitude;
- Indicate increasing degrees of precision by a system of grading according to the importance of the information (in the same way as the words in a Thesaurus are graded);
- Permit the independent reader to deduce the geographic position in longitude and latitude uniquely from the figures of the numbering code, each figure being taken successively and individually.
- Be suitable for data processing with the same techniques as automated cartography (computer-linked plotters), whatever the degree of precision employed to define the location of the information.

The proposed system fulfills these four requirements and necessitates only a seven-figure number for designating the desired precision (minutes of arc), providing that a preliminary positioning to within a  $10^\circ \times 10^\circ$  area has been carried out.

### **II. — THE NUMBERING PRINCIPLE**

Considering the degree of precision required, it would be logical to presume that the finder, the collector, the analyst or the user of the information already knows the geographic position of the spot to within  $10^\circ$  — in other words, we assume he is capable of deducing that the position of his data falls within a quadrilateral of  $10^\circ$  of latitude by  $10^\circ$  of longitude. At this stage the present Marsden numbering should be used. As an example, the French coasts fall almost entirely between  $40^\circ$  and  $50^\circ$  latitude North. Similarly, if we study a region of even the size of Brittany we know we shall be between  $47^\circ - 48^\circ$  North and  $1^\circ - 5^\circ$  West.

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The first code figure in the proposed system signifies the latitude and longitude units. The reader will thus retain in mind the  $10^\circ$  units of latitude and longitude defining the work area in a general way. The data processor will incorporate these two constants in an optional program.

**Progressive degrees of precision.**

Within an area defined by  $10^\circ$  latitude by  $10^\circ$  longitude the first step in positioning data will be the use of basic quadrilaterals of  $1^\circ \times 1^\circ$  identified by a two-figure number. This  $1^\circ \times 1^\circ$  area will then be subdivided, as is usually the case on charts, into 36 sub-divisions of  $10' \times 10'$  and referenced with a four-figure number. The following step is within these  $10' \times 10'$  areas where the subdivision is into twenty-five  $2' \times 2'$  quadrilaterals. This last division was selected on account of the two limiting factors already mentioned — the fact that some local fishermen

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do not wish to disclose positions with great accuracy and the concern that everyone may have the possibility of preserving his own professional secrets. Those who do not need to safeguard such interests and who are equipped with the necessary navigational means will wish to use the next and fourth degree of precision, that is to say the  $1' \times 1'$  division.

### **Procedure for graded numbering.**

The example given is for coding a quadrilateral of  $1' \times 1'$ .

$$\phi = 47^\circ 27' — 47^\circ 28' \text{ N}$$

$$G = 05^\circ 20' — 05^\circ 21' \text{ W}$$

In the system proposed here, this code will read :

75 22 60 1

The code is explained below.

### **Known locality.**

Atlantic coast of France

between latitudes  $\phi = 40^\circ — 50^\circ \text{ N}$   
between longitudes  $G = 0^\circ — 10^\circ \text{ W}$

### **First Sub-division ( $1^\circ \times 1^\circ$ ).**

Code 75

7 = Number indicating the unit of a degree in latitude  
i.e.  $\phi = 7 + [\text{constant} = 40] = 47^\circ — 48^\circ \text{ N}$

5 = Number indicating the unit of a degree in longitude  
i.e.  $G = 5 + [\text{constant} = 0] = 5^\circ — 6^\circ \text{ W}$

### **Second Sub-division ( $10' \times 10'$ ).**

Code 75 22

2 = Number indicating tens of minutes in latitude

$$47^\circ 20' — 47^\circ 30' \text{ N}$$

2 = Number indicating tens of minutes in longitude

$$05^\circ 20' — 05^\circ 30' \text{ W}$$

### **Third Sub-division ( $2' \times 2'$ ).**

Code 75 22 60

6 = Number indicating minute units (even numbers only) within the ten-minute unit of latitude defined above.

$$47^\circ 26' — 47^\circ 28' \text{ N}$$

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0 = Number indicating minute units (even numbers only) within the ten-minute unit of longitude defined above.

$05^{\circ}20'$  —  $05^{\circ}22'$  W

**Fourth Sub-division ( $1' \times 1'$ ).**

**Code 75 22 60 1**

= Code for the inter-cardinal compass points

NE = 1

SE = 2

NW = 3

SW = 4

$1' = + 1'$  in latitude  
 $+ 0$  in longitude

75 22 60 1

$\phi = 47^{\circ}27'$  —  $47^{\circ}28'$  N

G =  $05^{\circ}20'$  —  $05^{\circ}21'$  W

### CONCLUSION

The numbering system proposed necessitates a seven-figure number to define a quadrilateral of  $1'$  of latitude and longitude. Note that we started with the position already defined as falling within two parallels of latitude and two meridians of longitude  $10^{\circ}$  (or multiples of  $10^{\circ}$ ) apart.

In this way, processing of information — whatever the degree of precision of its location — is made possible in terms of a degree to a minute of arc, and with this system we can pass direct from the code to the geographic position without need of tables or charts. Furthermore it is compatible with computer techniques in automated cartography.

Thus it is not applicable to the problems usually encountered in cases of a precision of the degree or larger, for which it was not intended, and where the Marsden Square system — or even better, the improved BAUDIN-LAURENCIN system — will generally be utilised.

The applications of the system of numbering described here are essentially to a wide variety of work on coastal strips from the coastline up to the continental margin. Its precision and its excellent definition were initially devised for collecting information about the grounds of local fishermen, but the system could be used in such fields as the improvement of offshore concessions and the monitoring of the effect of urban sewage on benthic life in studies of the movement of coastal sediments.

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