BUILDING THE FIFTH EDITION: AN EXERCISE IN COOPERATION

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Executive summary

This paper describes how a combination of forces and a combination of willing people from a number of disciplines achieved the creation of the first bathymetric map of the world ocean made up from depth data supplied by all nations and corrected to a known standard of quality which was clearly shown to users of the maps.

Part 1 Setting the stage—the world as it was when the Fifth Edition began

"The Sixties." The phase is evocative of cultural change and upheaval, of hippies and civil rights and anti-war protests and student unrest. A period of major change almost inevitably leads to a new period of construction and order, and the field of Ocean Mapping was no different. By the early Seventies, four constructive trends were emerging that were to impact how the deep oceans were mapped. First, science: the emergence of marine geology, and its findings, which led to the observation of sea floor spreading. Eventually this would completely revolutionize all of geology through the development of plate tectonic theory, but when the Fifth Edition began, geology was still a battleground and it would take years for the raging disputes before it subsided. Second, technology: the vast promise of computer cartography was being touted by its early adapters as the wave of the future, one in which all maps would be easily made at the push of a button. Eventually, much of this potential was to be realized, but at a much higher cost and over a much longer time scale than early advocates imagined. Third, international relations: the growing awareness of potential mineral wealth from the deep sea floor led concern among nations as to who would benefit from these resources, which led to the convocation of the Third United Nations Conference on the Law of the Sea (UNCLOS III). Fourth, organizational: the International Hydrographic Organization (IHO) had increased its membership and influence, and those member states were becoming accustomed to working together in international cooperative endeavors. Unfortunately, not everything was positive. The Cold War raged, and part of it was fought in the deep oceans by submarines. It provided another reason to map the deep oceans so that submarines could be hidden, and found, and deep ocean research funding became available to indirectly support these activities.

This paper describes how these forces conspired to positively impact the General Bathymetric Chart of the Oceans (GEBCO) and lead to the creation of the Fifth Edition.

1.a Timeline: dates of events that impacted the Fifth Edition

1959	Heezen and Tharpe relief map
1967	"Common Heritage of Mankind" concept introduced to UN TRANSIT positioning satellite made public
1968	Deep Sea Drilling Project on begins
1970	Last sheet of the Fourth Edition published IOC establishes Group of Experts on Long Term Scientific Policy and Planning
1973	SCOR WG 41 studies producing a world map and presents formal recommendations in April.
1973	GEBCO Guiding Committee (IHO) endorsed the recommendations of the SCOR WG

	June Third United Nations Conference on the Law of the Sea (UNCLOS III) begins GLORIA surveys begin
1974	First meeting of joint IOC/IHO Guiding Committee (UNESCO, Paris)
1975	Cartographic specifications provisionally accepted First sheet of the Fifth Edition (5.05) published by the Canadian Hydrographic Service Sheet 5.05 presented to the delegates at the United Nations Conference on Law of the Sea
1977	Hot vents discovered on oceanic ridge
1980	Carters Echo-sounding correction tables published replacing Mathews Tables
1981	IHB publication B-6 'Standardisation of Undersea Feature Names' published IOC International Bathymetric Chart of the Mediterranean published First commercial GPS receiver sold, too late to be used for Fifth Edition
1983	United Nations Convention on the Law of the Sea signed Interpretations of NASA Seasat (flown 1978) altimeter data show seafloor
1984	GEBCO Fifth Edition publication completed
1985	"The relief of the surface of the earth" published as the first computer- modeled relief map

1.b Changing science and the evolution of knowledge of sea floor morphology—cause and effect intermingled

In the paper immediately preceding this one, Tony Laughton has given a detailed analysis of the impact on ocean mapping of the post-war revolution in marine geology that would lead to a complete revolution in the earth sciences. (Laughton, this volume). Essentially, the modern science of marine geology was built using the instrumentation developed or refined in World War II. That war had stimulated or engendered research into underwater acoustics, seismology, magnetics, sedimentology and long-range navigation to locate vessels far offshore, all of which were subsequently steadily improved and applied to collect more widespread data sets. Wells and Grant (this volume) summarize the status of depth measurement and position determination techniques for data collected and made available for the Fifth Edition. As new data were acquired, it began to change the commonly accepted view of the shape of the ocean floor. For example, continuous echo sounding profiles across the sea floor, even with the smoothing effects introduced by the spreading of sound in water, revealed that the sea floor was much rougher than had been previously envisioned. (There were textbooks when I was a student saying that the sea floor was smooth.)

More important perhaps is that bathymetry was not considered in isolation. Research ships collected magnetic field data, for example, and when features were discovered on magnetic maps, a search for a causal body on the sea floor began with examining the bathymetric data for morphological expression of the feature. When seismic cross-sections and gravity anomalies were added to the evidence, it became clear that the shape of the sea floor was not random, but related to geologic structure and events that combined over time to produce a surface with a shape that was a response to it's history. Existing bathymetric maps did not show such shapes. Some of the differences were due to scale, some due to the paucity of data from which the earlier map was made, but the biggest difference came from the way the contours had been drawn around the data.

Bathymetry thus entered a stage wherein scientists were trying to fit natural, believable surfaces to widely dispersed and poorly oriented data, while simultaneously developing an understanding of how the surface was formed and what constituted "natural". Out of this conflict came support for, perhaps confirmation of, seafloor spreading, and credible bathymetric contours for use in GEBCO.

1.c "Computer cartography"

Computers are so pervasive today that it is sometimes a little difficult to remember that they only really emerged recently. During the production of the Fifth Edition, they were still caught between the "use them for everything" and "they will never work" ideologies. Producers of the Fifth Edition had two major possible uses for them, in the data interpretation stage and in the map production stage.

Geophysicists working on the interpretation of potential field data began using computers for the many calculations their specialties demanded, and it was only natural for them to use the machines more and more extensively. Initially, they used computers to simply plot values on maps, but it was not long before computers were generating contours, too. In part because they are subject to restraints of gradient, potential field surfaces are generally smoother than the sea floor, and the mathematics of surface fitting was simpler. Nevertheless, some workers started applying these automated contouring programs to bathymetry data. However it was realized that the seafloor was too rough, the data too sparse and the contouring algorithms too crude to produce meaningful results, and the Fifth Edition was produced using human interpretation.

Computers were beginning to be used in the cartographic production processes, too. At that time, the CHS had systems that could automatically draw grids and graticules, but its development efforts were focused on using computers in the production of nautical charts. Consequently it was decided to use manual methods to draw the Fifth Edition.

1.d The United Nations Convention on the Law of the Sea

Shortly after WW2, when American President Truman declared that the continental shelf adjacent to the USA was "subject to jurisdiction of the United States", the question of how far seaward a Coastal State exercised its sovereignty was reopened. The principal attraction was oil and gas, which were being found in increasing abundance on the physiographic continental shelves. In addition, there was a great deal of public attention directed towards the development of technology to mine "manganese" nodules from the deep sea floor. In the 1870s, the Challenger Expedition had discovered polymetallic nodules, made of iron, manganese, copper, nickel and cobalt, which were strategic metals during the Cold War. The possibility that the perceived mineral wealth of the deep seabed, as well as the petroleum from the continental shelves, would not benefit the poor nations of the world led to the introduction in 1967 at the United Nations General Assembly of the concept of the "Common Heritage of Mankind". Ownership of sea floor resources became a factor in the convening of the Third United Nations Conference on the Law of the Sea (UNCLOS III) in 1973. Over the next nine years diplomats from most countries struggled with the drafting of what was to become the United Nations Convention on the Law of the Sea, signed in 1983 (United Nations 1983).

This major diplomatic effort influenced the perception of the oceans at many levels of most Governments. General perception worldwide was that the oceans were more important than perhaps had been previously realized and that they should receive increasing attention. Bathymetric mapping was looked on favorably at many levels of Government, and although funding was not always easy to obtain, some funding was available for Ocean Mapping. Indirectly, the Fifth Edition was able to benefit from these favorable conditions.

It is also possible that the Fifth Edition influenced the framers of UNCLOS. Sheet 5.05 was presented at UNCLOSIII and the IOC formed a group of experts to advise on Article 76 Continental Shelf, for example. Guy (this volume) discusses bathymetry and UNCLOS.

1.e Hydrographic antecedents to the Fifth Edition—setting the stage

In many ways, the Fifth Edition had its genesis in the Third Edition. (The Third and Fourth Editions are described by Kerr, this volume.) In retrospect, the major achievement of the Third Edition may well have been the development of a series of 1:1 000 000 Plotting Sheets on which sounding data were entered when provided by the Hydrographic Offices of the member nations to the IHO. These plotting sheets formed the basis of the first truly international data bank for bathymetry, and firmly established the International Hydrographic Bureau as the world data center for bathymetry, a function it fulfills to this day. This process was further improved during the production of the Fourth Edition when several volunteering Member States undertook the preparation of the 1:1 000 000 plotting sheets for a specified area of the world, rather than having the plotting done at the IHB, with the advantage of local specialized knowledge that each HO could bring to the plotting area. These became the standard data collection document for oceanographic bathymetry. More significant, the plotting sheets were a clear demonstration that 22 of the major Hydrographic Offices of the world were committed to oceanic hydrography and to cooperation on a world wide scale, demonstrating the universality of hydrography and it's service to mankind. Moreover, they had created an organizational structure to make this commitment a reality, one that would serve the Fifth Edition well. The data center and its method of operations was vastly improved during the Fifth Edition and continues to improve –see Harper and Sharman, (this volume.)

Part 2 Launching the Fifth Edition

By the end of the Sixties, marine scientists were faced with an unhappy situation in which more and better data were being collected and a mechanism existed for assembling the data world wide. Marine geology was developing an understanding of the origin and evolution of the sea floor and of the processes active on it. These comprised the essential components of a world series but no satisfactory world bathymetry map existed. An organizational solution had to be found.

In 1970, the Intergovernmental Oceanographic Commission (IOC) of UNESCO set up a Group of Experts on Long Term Scientific Policy and Planning. Among its activities, it examined morphological charting of the sea floor and recommended that the Commission participate in the production of a world bathymetric map bearing in mind that the IHB was the most experienced body in this field. To achieve this end, Working Group 41 of the Scientific Committee on Oceanic Research (SCOR) was formed to study the methodology involved in producing a world map of the oceans and to make recommendation on how this was best to be achieved. As a consequence, the Intergovernmental Oceanographic Commission (IOC) and the International Hydrographic Organization (IHO) entered into a new agreement to set up a Joint IOC/IHO Guiding Committee for GEBCO comprising five representatives from each community, and no more than one from any one country. (Laughton 2002) The mandate that each member understood was to create a totally new approach to GEBCO.

2.a Strategy

An exciting aspect of participating in any ongoing series of human endeavor is the breaking of new ground that comes with the introduction of a new edition. New techniques are usually available, new ideas and interpretations can be applied, a sense of improving and rebuilding permeates the air. It is tempting to take an "out with the old, in with the new" attitude, an attitude which should not be taken to extremes. Instead, a careful evaluation should be made of the strengths and weaknesses of the outgoing edition, and its best features and achievements preserved within the new edition. Fortunately, that is what happened among the constructors of the Fifth Edition. There was a constant awareness of the need to balance the introduction of new approaches while maintaining the most valuable elements of the preceding years.

On the other hand, one of the real drivers in the production of the Fifth Edition was impatience. There was a general feeling among the participants that the world had waited far too long for a proper map of the world ocean, and that one was needed urgently. Our awareness of how multinational projects could have expandable deadlines and the desire not to let this happen to us drove us to act quickly. This sense of immediacy certainly helped attract new players /coordinators and attracted the donation of new data sets. Most researchers like to see their data used rather than simply being stored.

Elements of the new strategy are elaborated below.

2.b Role of coordinators

A key element to the success of the Fifth Edition was the introduction of the concept of having one or more scientists assume responsibility for the interpretation of the data within an area. Named “scientific coordinator” these experts were in fact authors of a map sheet, and they undertook this role with energy and responsibility. They brought a complete suit of scientific talents and skills with them, and to some extent staked their scientific reputations on the contents of the map in the same way they would with a paper published in a refereed journal. This was one major difference from the fourth Edition in that the data were interpreted as samples of a complex geomorphologic surface, and the contours were not just lines drawn around the soundings. Sheets were subject to editorial review by the guiding committee before being passed to drafting. Appendix A1 lists the names of the coordinators and the sheets for which they were responsible.

The following is a brief description of how data available to scientific coordinators of the Fifth Edition data were transformed into information in the form of contours. Most coordinators began with data that they or their lab had already collected for part of the map area. This was never enough and the first step was therefor to assemble depth data from all available sources. In theory, the GEBCO plotting sheets at 1:1 000 000 contained all this data, but in practice there was always a delay, sometimes significant, between data being collected and data appearing on the plotting sheets. Furthermore, not all institutions submitted their data to the IHB, for a variety of reasons. However, the coordinators were usually aware of all data “in the pipeline” and were well placed to request the holders of the data to allow it to be incorporated immediately into GEBCO . The positive response to most of these requests was another indication that the international science community wanted a world bathymetric map.

Each sheet covered a vast portion of the earth, some 90 degrees of longitude. Within this one-sixteenth of the globe, there were small areas covered by cohesive bathymetric data sets that used the same positioning and sounding instruments, were self-checking through having numerous crossovers and were laid out to optimally reveal some of the sea floor features known to exist in the region. Unfortunately, these were very much the exception. For the great bulk of the map sheet, data were collected over a number of years using different positioning methods with different accuracies and different sounding methods, with the velocity of sound only poorly understood, and tidal adjustment unknown, had a distribution that was random in space and had a pattern of data unrelated to the sea floor morphology.

For some portion of the map sheet, the coordinator would have original echograms. An echogram is a trace of the sea floor as captured by a series of individual soundings taken several times a second from a research platform moving slowly. The returned trace is virtually continuous and can be used in its raw form to interpret the morphology of the sea floor. To compare between the results of different echo sounders and to make quantitative maps, it is necessary to sample the returned echo at discrete locations in space and post the depth values or soundings on plotting sheets.

For the Fifth Edition, soundings were posted (and re-posted) manually: in manual plotting there is a limit to the horizontal wavelength of sea floor features that the sounding can capture. The hand drawn number representing depths must be large enough to read, and therefore the relationship between plotting sheet scale and the size of the numerals dictates the wavelength of features captured from the echograms. Depths plotted and made available were not necessarily selected from echograms in a consistent manner. Trying to capture the shape of the profile may have been the objective of scientific plotters, but hydrographers are preoccupied with shallower soundings and when the profile between sampling points is shallower than at the sampling points, hydrographers traditionally either insert an extra sounding or move the shallowest value to one of the equally-spaced sampling points. Deeper features occurring between soundings are ignored in this approach, while the location and extent of the peaks of some shallower features is distorted.

One of the first actions performed on this collection of data that varied enormously in provenance and age was to check it for blunders. Blunders include errors introduced by plotting metres and fathoms together, or plotting depths corrected according to different assumed velocities of sound, reading the wrong phase in the echo-sounder, reading deep scattering layer for bottom, applying velocity correction incorrectly. Once the gross errors have been detected they can often be corrected: if not, the data, in theory, must be rejected, but totally rejecting data from a sparse data set is difficult and may be impossible if there is not other data for tens of kilometers. The shape information it contains may still useful to some degree and should be salvaged if at all possible. This is especially important when the track in question is the only one oriented in that particular direction.

Blunders are one class of errors, with systematic errors and random errors forming the other types in classical error theory. It was extremely difficult to check for these type of error in Fifth Edition data, and they were largely accounted for during interpretation and by changing scale. Working at a scale of 1:1 000 000 for a publication scale of 1:10 000 000 meant that to a large extent these errors were absorbed in the scale reduction process. The edition of IHO specs SP 44 in force during the Fifth Edition specified that where echo-sounding profiles cross, the two depths at the point of intersection should differ by less than 1% and this was used as a rule of thumb –if the data met this, then it was used. If it did not, then sometimes it could be adjusted so that it did.

The next stage was interpretation. The coordinators set out to interpret something they had never seen, the shape of the sea floor, from data whose position could be incorrect by several miles, where different beam-widths of the echo sounder could have caused different smoothing of the sea floor, where numerical values representing depths could have been selected in different ways, and where the methods used to collect some of the data was unknown. The arrangement of the data may or may not have had a relationship to the shape they were trying to capture. Most importantly, single beam profiles captured the sea floor in profile and any individual profile might contain features that were very short in relation to the horizontal distance to the next profile. Joining up the profiles by means of contours would be difficult since it was logical that short wavelength features existed on the sea floor between profiles, but they had not been directly ensonified and recorded. The scientific coordinators were armed with their knowledge of sea floor processes, some ancillary geophysical and physical oceanographic information and a great deal of enthusiasm.

Contours were the chosen graphical device for the task of portraying a three-dimensional object on a two-dimensional medium. Contouring is the process of constructing a surface through a set of data points by means of lines representing equal values of the quantity the data represent, in this case, depth.

The Fifth Edition contours were drawn "by hand", the hand being guided by the brain and eye of the scientific coordinator. This was probably the last major Ocean Mapping project to be constructed entirely by hand, since during the production period, significant progress was made in the field of contouring by computer. With the paucity of data available to the Fifth Edition and the low level of development of computer techniques, contouring by hand was the most suitable. It took advantage of information that was not contained in the numerical soundings and could not have been dealt with by the software of the time. This additional information included: information on shape and depth contained in the echograms *between* the numerical soundings, information from other instruments or different types of data e.g. trends in the magnetic field, and accumulated knowledge of natural shapes sea floor contours can take appropriate to the geomorphological province being contoured. (Monahan 2000) See Shenke (this volume) for more recent developments in this field.

2.c Partners and partnerships

Many partners contributed to the success of the Fifth Edition. Contributions of the major organizations, IHO and IOC have been discussed by other speakers and need no further elaboration. There were a great many others. Every scrap of data that was collected and submitted was collected by a partner. The home organizations of the members of the Guiding Committee, its sub-committees, the scientific coordinators and advisors were all partners. The groups who supplied information or the land portions of the map sheets were all partners. There were so many that they cannot be listed in the space available for this paper: many are listed in the booklet that accompanied the Boxed Set. (IHO IOC and CHS 1984) All deserve credit for successful completion of the Fifth Edition.

Part 3. The Maps

The Canadian Hydrographic Service volunteered to produce the map sheets of the series. Once the coordinators had produced their rough contour sheets, and after the peer review process had been complied with, source material was sent to the CHS who transformed the draft documents into thousands of copies of the paper charts. Since some of the coordinators worked with little institutional support, in some cases the CHS transformed the draft material to a common scale and projection to produce a draft of the entire sheet prior to peer review.

3.a Shoreline and topography

Shoreline and topography for the entire earth were not something that was readily available at that time, and was beyond the experience of most of us. (Contrast this with today when the world is freely downloadable from dozens of web sites). The Institut Geographique National were amenable to making the shoreline and topography from the Fourth Edition available: these were Mercator projection at 1:10 000 000 at the equator scale and did not cover the polar regions. Nevertheless they existed and could be used immediately, and this, as well as their high quality, made them an easy and natural choice. As the project developed, and Polar sheets were added to the scheme, high latitude grid and shoreline were needed. The American Geographical Society provided Arctic and Antarctic shoreline, Scott Polar Research Institute, Cambridge University, provided under-ice contours for the Antarctic and updates to portions of the Antarctic shorelines and the Elektromagnetics Institute, Technical University of Denmark provided under- ice contours for Greenland.

3.b Depth portrayal

Depths were to be shown by means of contours interpreted by experienced marine geoscientists. Unlike earlier editions, few spot soundings were to be shown, those that revealed significant depths that the contours could not capture. Depths were corrected for the varying velocity of sound in seawater by Mathews tables. (Matthews 1939) Contour intervals were selected to be appropriate to the scale of the sheets, the morphology of the sea floor and the amount of data available. Generally, the shallowest contour was at 200m, since this would usually capture features on the continental shelves. After that, the interval switched to a contour every 500m, beginning at 500m. Variations in this plan were necessary in places: for instance, in areas of steep continental slope, the 500s are occasionally omitted, and in the Arctic Ocean data density permitted only the portrayal of 1000 m contours.

3.c Reliability –uncertainty indicators

To allow readers of the maps to judge how much faith to put in them for every portion of the seafloor, the reliability of the contours was indicated by showing the ships' tracks along which data had been collected as a thin gray line, or in the case of a comprehensive survey too detailed to be shown at map scale, as an outlined box. Some experiments were performed with printing the tracks on the back of the map sheet, the theory being that they would be visible when the sheet was laid on a light table. This was abandoned since it would not work for maps that were wall-mounted.

3.d Projection

The cartographic starting point was the reproduction material supplied by the IGN consisting of land topography, drainage and shoreline registered to a Mercator grid. Mercator's appropriateness was debated at some length, recognizing that all projections distort in some defined manner, and any choice would have to be a compromise. Developed for navigation, Mercator's design objective is to show bearings taken from compasses as straight lines. Although this attribute has served seafarers well for hundreds of years, on Mercator charts shapes and areas are distorted, to a degree that becomes noticeable when the projection is applied to large areas. Since it was desirable to produce sheets that could easily butt-join to form coverage of entire oceans and even the whole world, it was necessary to use only one scaling or reference latitude, the equator, meaning that distortions would be quite large on sheets covering high latitudes. To help reduce this in order to produce a map that best portrayed the earth, it was decided that the Mercator coverage would extend only to 72 degrees North and South, while the polar regions would be mapped on a stereographic projection extending from the poles to 64 degrees North and South. On sheet 5.00, which covers the entire world, both projections are used.

Mercator had been used in the first four editions, primarily because of ease of plotting. For this reason, the 1;1M plotting sheets, introduced during the Third Edition, were based on the Mercator projection. Since the data on them would be used for the Fifth Edition, using a projection other than Mercator would have introduced another step, that of projection transformation, into the production stream. At that time, computer plotting was still very much in its infancy and not reliable so that time consuming analogue techniques would have had to be used. Not having to make projection transformations added to the value of using the IGN source material.

3.e Sheet Layout

One of the first tasks was to divide the oceans into manageable areas. A balance had to be found between the cartographic issue of the portion of the earth that could be covered by a printable map sheet and the fact that the scientific coordinators tended to have knowledge localized to a particular area of the sea bounded by physiographic features which did not always coincide with map sheet boundaries. The IGN source material from the Fourth Edition was arranged as 16 sheets extending 90 degrees longitudinally starting from Greenwich. Although this layout functioned well in the northern hemisphere, coverage of the southern hemisphere was improved by shifting the sheet boundaries 20 degrees east. This allowed more complete portrayal of significant oceanic features on one sheet. This advantage was extended to seven sheets by enlarging them to cover a small extra area, like the west coast of Hudson Bay, that would otherwise result in the user needing two sheets.

Polar Sheets where produced on the stereographic projection. In this projection, the earth is mapped onto a plane which is tangent at one point; with GEBCO the point of tangency was taken as the Poles (hence the projection is sometimes referred to as Polar Stereographic). Geometry consists of rays originating at the point on the earth opposite to the point of tangency, projecting through the earth onto the tangent plane. It is an equal angle projection so that angular measurements over short distances are correct. Scale factor is 1:6 000 000 at 75º.

It was seen that many users would find a sheet covering the entire world to be valuable. One was made up to include the 1:10 000 000 Mercator sheets reduced to 1:35 000 000 and the polar sheets included at 1: 25 000 000.

3.f Languages used

Language use on the printed sheets was in keeping with the cooperative nature of the endeavor. For the first print run, the 1:10 000 000 scale sheets used English for the water names, and French for the land names. Thus we have the “English Channel” between UK and France, while the capital of the UK is “Londres”. On the 1: 35 000 000 overall sheet, this was relaxed a little, and there are some English names on some land features. Subsequent press runs were made on which Russian, Spanish and Chinese were used.

3.g Boxed set

large printed map sheets require special storage facilties, normaly found only in lare laborities and map libraries. To enable individual users world wide to conviently store and have access to GEBCO, a boxed set of folded maps was produced. Included in it was a legend printed separately for use when the 1:10 000 000 sheets were trimmed and wall mounted, and a booklet. In addition to a general description of the project, the booklet published with the boxed set (IHO IOC and CHS 1984) contained credits for each sheet of the series, references and sources for each sheet of the series, Guidelines for Geographical Names and Nomenclature, description of the International Hydrographic Organization as the World Data Centre for Bathymetry and other valuable information.

Clients in countries with foreign currency problems could buy GEBCO through UNIPUB using coupons.

Part 4 More than contours

4.a Nomenclature

An important activity from GEBCO’s earliest days was the development of international terminology for sea floor relief features and standards for nomenclature. During the production of the Fifth Edition, a Sub-Committee on Undersea Feature Names was established which conducted a significant review of the use of generic nomenclature in the published literature. From this, a comprehensive listing of generic terms was published in 1981 as IHB publication B-6 entitled 'Standardisation of Undersea Feature Names'. (GEBCO Nomenclature Committee 1981). Translated into French, Spanish and Russian using national published literature to support the definitions, this publication has seen widespread use throughout the marine sciences, and has been re-issued with updated editions. Following this success, the Sub-Committee turned its attention to the specific part of sea floor names. In this role, they researched the background of thousands of specific names. The results of this work appeared on the published GEBCO sheets and were published in a gazetteer (IHB publication B-8). To help with the new naming of features, the Sub-Committee developed a submission process and supporting documentation. Accomplishments in this area are summarized by Fisher and Huet (this volume).

Part 5 The Fifth Edition's behest

GEBCO is an on-going, constantly unfolding process. Although completion of the Fifth Edition was a major milestone, it was a milestone along a journey that has never stopped. One of the "facts of life" in Ocean Mapping is that as soon as a sheet is printed, new data will be collected that should be used to update it! This happened with the Fifth Edition and a number of the paper sheets were updated. As a cartographic footnote, some sheets were reprinted to bring them to a uniform color since the inks used had changed over the nine years of production. These activities were maintenance of the resource that the completed Fifth Edition had become.

The first major step forward that built on the Fifth Edition was the creation of the GEBCO Digital Atlas (GDA) (Jones, this volume), in which the contoured maps were digitized and made available on CD-ROM.. Not only did this allow users to exercise computer capabilities while using the maps, updated map sheets were also included, as was other related information. With succeeding editions of the GDA, the process of updating has been repeated.

Another significant step was realized though the production of a world-wide grid of depth values, a product highly desirable to physical oceanographers. (Carron, this volume)

There is more to the behest than these valuable products. There are the human and organizational elements. Producing the Fifth Edition was a clear demonstration that people from many nations representing different branches of marine science can work willingly and freely together applying their specialized knowledge and skills to the achievement of a common goal. The Fifth Edition is testimony to what men and women of good will can achieve.

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