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An approach to the preparation of the Hydrogeological Map of Africa

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Scientific topics related to the small-scale Hydrogeological Map of Africa, that is going to be prepared in the near future, are discussed and some suggestions are explained. Organization and financial problems of that mapping are also cosidered.*

INTRODUCTION

The hydrogeologic map of Africa, which is the subject of this discussion, will be the second international hydrogeological map covering the territory of an entire continent. The first such project — already nearing its completion — was the International Hydrogeological Map of Europe, scale 1 : 1,500,000 (Karrenberg, 1964). Some other international hydrogeological maps extend over large geologic or hydrographic regions each covering only several countries — like the map of magmatic and metamorphic terrains of western Africa, scale 1 : 2,000,000; map of the Lower Mekong basin, scale 1 : 5,000,000; and map of Lake Chad basin, scale 1 : 1,000,000 (Albinet, Dion & Moussu, 1973).

The IHME was well prepared. It was discussed and shaped for a long time so that as many as five model-maps of the first sheet, that of Bern, had been produced until the last version was accepted as the pattern for the entire map. It resulted with a well-balanced map in regard to its concept and final product. In designing the HMA, the IHME should serve as a model.

One more reason for using the IHME as a model is the fact that the IHME already comprises parts of northern Africa as well.

Apart from the necessity to follow the pattern of the map of Europe, the HMA should fulfill also two even more important tasks, (1) to provide the basis for a modern exploration and development of ground-water resources of Africa and (2) to enable a fair display of specific hydrogeologic conditions characterizing this continent.

Therefore, the HMA should follow cartographic principles established by the International Legend for Hydrogeological Maps (Anon., 1970) and the IHME legend (Karrenberg, Deutloff & Stempel)

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but there are other goals that should also be achieved and this may be accomplished by introducing certain changes into the IHME contents and through minor modifications of its legend.

Some proposals of cartographic solutions are briefly outlined in continuation as well as several suggestions on the organization of work and on the financial aspects.

ABOUT THE CONTENTS AND LEGEND OF THE MAP

If the proposed ground-water resources character of the HMA is accepted as its first priority objective, a considerably different approach to the presentation of aquifers and ground-water quality is to be applied here than it was the case with the IHME.

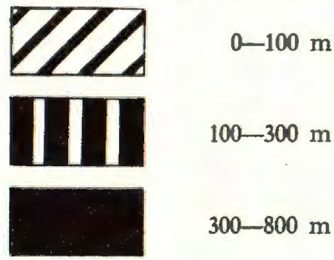
First of all, the differently painted areas, being the most expressive and obvious cartographic elements of each map, should be reserved only for aquifers and terrains without aquifers and not for formations composing the land surface. In that case, as in the European map, different colors indicate the types of porosity and a very general lithology while the shade reflects yielding or discharging capacity of aquifers (but only in terms of »major« and »minor« significance or »high« and »low« yielding). To the range of colors used in the IHME, two more colors may be added in order to distinguish the alluvial aquifers (blue) from other intergranular or porous aquifers (violet-blue) and the cavernous or karst aquifers (green or yellow-green) from other fissured aquifers (blue-green or pure green). The brown color retains its role, it indicates terrains with (1) local, very low-yielding and practically insignificant aquifers and (2) terrains practically or entirely without aquifers even to the depth of about 800 m.

Lightly shaded colors chould not only represent minor or low-yielding aquifers but also insufficiently explored promissing areas. Another recommendable solution would be, perhaps, to distinguish the areas by appropriate colors applied in dots.

The second important novelty would be to show the depth of ground water not only by contour lines or individual figures but also by the pattern in which the colors are applied, i. e. to alternate stripes of colored and white areas as shown in Fig. 1. In such a way, three depth zones are clearly differentiated, i. e. the areas where ground-water can be struck within the depths of 0—100 m, 100—300 m, and 300—800 m below ground surface. In order to facilitate such mapping and, in some regions, even to enable its realization, a wide tolerance may be allowed in the determination of these depth boundaries. For instance, in insufficiently explored areas, the 100 m boundary may be determined with accuracy of 20—50 m, the 300 m one could have the tolerance of 50—100 m, while the deepest one, 800 m, might err for as much as 100—200 m. Naturally, every effort should be made to decrease the inaccuracies in depth boundaries as much as possible.

Nevertheless, with all probable inaccuracies, such a map would offer a very useful perception of horizontal and vertical distribution of water-bearing media. The effect of thus vividly displayed areas with different depths of ground water need no further explanation, particularly if the

Fig. 1. — Depth to ground water



(The color of painted areas reflects the aquifer properties)

development of ground-water resources is the matter of our consideration. This cartographic element has been successfully applied for karst regions in Yugoslavia, in the map of Croatia, and it will be also used in a new, small-scale map of Yugoslavia (Šarin & Urbiha, 1977; Šarin, 1982).

Where there are sufficient data to construct the depth-to-water contour lines they may be drawn as well.

If two or three important but different aquifers overlap each other, the underlain parts might be shown by colored hatches patterned similarly to the painted areas indicating not overlapped parts of the aquifers.

Water quality should be shown much more accurately than in the IHME because of its significance in tropic and subtropic zones. Under African hydrogeologic and geographical conditions, the quality of water for drinking is, naturally, more important than of that for irrigation, but both properties should be indicated in the map. Three components control both properties in most cases: total dissolved solids or electrical conductance, chloride content and sodium content.

TDS and Cl-content, along with the data of other chemical components if available, may be used to classify drinking water quality into four classes: A — suitable for human use, B — suitable for cattle, C — suitable for other livestock, D — unsuitable for drinking. In many countries, regional water quality criteria, especially for the human usage, should be respected even more then international standards.

TDS or EC and Na-content, expressed as salinity and sodium hazards after L. C. Wilcox and U. S. Salinity Laboratory Staff (Hemm, 1959, p. 251) serve to classify the quality of water for irrigation also into four classes which could be named according to another classification proposed by the same author: 1 — good, 2 — fair, 3 — permissible, and 4 — unsuitable for irrigation.

There are several ways to shaw water quality classes on the map: by writing codes for drinking and irrigation qualities (A, B, C, D and 1, 2, 3, 4) in combined forms (A1, A2, B1, etc.) near sampled water points; by inscribing the pertinent combined code within each bordered water quality zone; by drawing another, marginal map of several times smaller scale then the main map which woud show water classes with special geometrically shaped signs; or by hatching differently each zone. If anything is drawn or written in the main map concerning water quality, the orange color should be used as in the IHME.

The temperature of thermal waters should be inscribed in orange figures near the sings of pertaining water points. The criterion for thermal water is hydrogeological (10° C or more above mean annual temperature) and not the balneological (any natural water having temperature 20° C or more).

The maximal yields of dug and drilled wells should be indicated in the same manner as it is done for minimal spring discharges, i. e. by red dots of different sizes. The signs for dug wells should differ from those for drilled wells. Intermittent springs should also be shown in different sizes, but this time the criterion is mean annual discharge. All the discharges and yields may be graded as follows: less then 1, 1—10, 10—100, more then 100 l/s. In karst areas of northwestern Africa, the caves and shafts with ground water and dry caves and shafts longer than 50 m (or 100 m) should also be shown.

Lithologic signs need not be drawn. If they are to be applied, which lithology to indicate? The lithology of the uppermost formation composing the land surface or the lithology of indicated aquifer? In the latter case, what to do when two or three aquifers overlap each other?

The inclusion of water quality and quantity data of surface waters is strongly recommended because they would provide valuable comparative information when regional ground-water resources are being evaluated. In regard to water quality, it is quite clear that close mutual dependance between surface and ground waters does not exist only in the case of study of deep artesian waters. In all the other cases that dependence does exist. Furthermore, stream flow data will also provide valuable information. The mean rate of flow in m^3/s, number of months per year of active river flow and drainage area in square kilometers can be written one below the other near the gaging station.

Naturally, the idea of introducing surface water data into the HMA may provoke a heave opposition. Still it is recommended at least not be reject this proposal without a thorough discussion of pró and contra-reasons.

ON THE PROJECT REALIZATION

From the position of a considerable experience with equivalent or similar work, it appears that the mapping discussed here may be carried out with better results and less problems if the proposals outlined hereinafter are accepted.

First of all, it is necessary to form a Commission which will be responsible for the entire project.

This Commission should be composed of (1) delegates of African countries, (2) representatives of U. N. agencies involved and (3) of several foreign experts. Tke Executive Council could be the Commission's managing board and might consist of five members: Commission's president, two secretaries, one for scientific and other for administrative affairs, and two more persons.

The foreign (non-African) experts* and several experienced African hydrogeologists, chosen among the Commission's members, might form the Commission's Working Group. This Group should be headed by the Commission's scientific secretary.

The Commission would have to accomplish the following tasks:

— to elaborate the design of the map;
— to provide funding for covering of the mapping expenses;
— to organize the election of national redactors and to elect chief redactors for each sheet;
— to supervise the mapping (annual plans, supervision of their realization, annual reports);
— to organize the printing of completed sheets and the distribution of printed maps.

The Working Group of the Commission should prepare the design of the HMA defining: the purpose of the map, its contents, method of execution (in outlines), professional and technical staff, phases of project realization, mapping and printing expenses. Also a complete and graphically precise legend of the HMA has to be included.

The Group would decide how, when and who of its members would prepare the design. The design should be subject to the discussion and revision of all the members of the Working Group whereupon it should be presented before the whole Commission. If the design would not arise substantial objections, it might be completed in its preliminary form.

It is highly reccommended that the preliminary design be verified during a stage of a pilot mapping before its final approval. Within that period several regions of Africa should be pilot-mapped on the basis of the preliminary design. The regions selected for that test mapping should differ both hydrogeologically and physiographically and need not occupy too large areas. The interesting regions are: large alluvial valleys, areas where the Nubian sandstone is tapped, karst areas at the north-west, rainy forests, highland savannas, mountainous regions etc.

Cartographic problems and requests for corrections of the preliminary design should be discussed within the Working Group and all justified objections should be accepted. After solving the discussed problems, the preliminary design might be submitted to the Commisison for the second presentation and approval. Once finally approved, the design becomes the official mapping instructions on the basis of which the HMA is to be made.

During the execution of the HMA, the Working Group or part of it should supervise scientifically the mapping and make final redaction of each sheet of the completed manuscripts before sending them to printing.

For the time being, not every African country has sufficiently experienced professionals who would be able to prepare the discussed map for its national territory without the help of some other African or non-

* Among the non-African consultants, the presence of a representative of the Bureau de Recherches Géologiques et Miniers from France and of the Institute of Geological Sciences from the Great Britain would be very valuable as well as the participation of the president of the Commision for Hydrogeological Maps of the International Association of Hydrogeologists which is in charge of the IHME.

-African countries or individuals. However, should any foreing expert assistance be considered, the available domestic professional and tecnical staff will always have the preference. Even unexperienced local professionals must participate, naturally, under the supervision of experienced foreign hydrogeologists. Namely, it will be the unique chance to educate local hydrogeologists so that they would be able to continue that work indenpendently in the future on preparation of other medium or large-scale hydrogeologic maps of their countries.

Many African countries will not be able to provide all of the funding needed for completion of the HMA for their national territory. The solution would be in the engagement of United Nations agencies. Some of them — like the UNDP, FAO, UNICEF, and recently also their special officies, like the UN Sahelian Office — have already for years been giving their financial and technical support to a great number of projects dealing with the ground-water exploration and development. They have been already financially aiding even the preparation of hydrogeologic maps.

Moreover, since recently there is the evidence of serious intentions to reorganize the present Centre for Water, in Zagreb, Yugoslavia, into a special U. N. office to be in charge of the promotion of tecnical cooperation among developing countries in the field of (surface and ground) water exploration and development. A project like the one that is the subject of this discussion, i. e. the preparation of the HMA, represents a perfect examples of the sort of cooperation onto which should be focused the activity of such a U. N. unit.

If the U. N. organizations have not as yet been engaged in the preparation of the HMA, the first and most important objective would be to ensure their substantial involvement.

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