GROUNDWATER RESOURCES IN CENTRAL SOMALIA *

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ABSTRACT

The hydrogeological research in Central Somalia has covered about 100.000 sq.km comprising the Galgaduud Region and part of the Mudugh and Hiiraan regions.

The results of the stratigraphies of the deep wells drilled for the purpose of exploiting the local water resources point to a different geological interpretation of the underground as compared with that known from literature. A possible relationship between the Mudugh-Merca Suite and the Daban Series is discussed whereas the discovery of olivinic basalts at depths rangin between 30 and 120 m provides arguments for criticism and to form hypothesis.

The well water conductivity has permitted the plotting of a map of such parameter for the entire territory under survey as well as to establish a correlation between conductivity distribution and geological interpretation. A similar approach made it possible to trace useful elements for research and exploitation of the aquifers

RIASSUNTO

Sono state condotte ricerche idrogeologiche nella Somalia Centrale su una superficie di circa 100.000 km^2, comprendente il Galgaduud e parte del Mudugh e dell'Hiiraan.

Dalle stratigrafie dei pozzi profondi, scavati per sfruttare le risorse idriche locali, è stato possibile tracciare delle sezioni idrogeologiche che danno una interprtetazione geologica diversa da quella nota dalla letteratura. Si discutono i possibili rapporti tra la Mudugh-Merca Suite e la Daban Serie mentre il ritrovamento di basalti olivinici a profondità variabili tra 30 e 120 m fornisce elementi di critica e stimola ipotesi.

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Le misure della conduttività delle acque e delle rare sorgenti ha permesso di redigere una carta della distribuzione di questo parametro per tutto il territorio considerato, corredandola con l'interpretazione geologica. Si è potuto così fornire elementi utili alla ricerca ed allo sfruttamento degli acquiferi.

FOREWORD

The territory under review nearly completely embraces an area of about 100.000 sq.km of the Galgaduud Region as well as the left side of the Shabeelle Valley from Bulo Burti to Joowhat (and Uarschiek) in the Hiiraan and Central Shabeelle Regions; at North it arrives near the parallel of Dh/Mareeb-Obbia (Mudugh Regione).

About 100 water wells served to take measurements of static levels and well water conductivity; 35 drill logs collected or taken from previous studies made the plotting of the hydrogeological cross sections mentioned herein possible.

One of the major difficulties was met when attempting the correct toponymical spelling, the greater part being indicated according to the 1:100.000 topographical map of the Somali Democratic Republic; quotations are shown in the original spelling. The basic topographycal map was obtained by various photographic techniques, starting from Sheets 21 and 25 done in Washington in 1968 and 1978 (Edition 4-AMS and 6-DMA, and then re-drawn by adding the wells of wihich the geographical co-ordinates were available. The old 1:100.000 Italian topographical maps came in very handy as well.

STUDY STRATEGY

From the geological viewpoint the studies pf S.U. Barnes(1976) and obviously the Geological Map of Ethiopia and Somalia on a 1:2.000.000 scale drawn by Italian geologists belonging to the Department of Geology and Paleontology of Florence University (1979), ware of basic importance.

But we must remember the fondamental researches executed by the Faclty of Geology of National Somali University; results are almost entirely published on the "Quaderni di Geologia della Somalia"; we mentioned only the works really relative to our study.

The hydro-geological aspects of the region are mentioned in the report by A.P. Popov and A.L. Kidwai (United Nations Development Programme, Mogadiscio 1972). which must be considered a basic synthesis of Somalian hydrogeology. Viceversa, under this aspect the left side of the Shabeelle Walley had already been described well by C. Faillace

(1964), an intelligent survey one never tires of referring to.

These papers will be mentioned in greater detail whenever dealing with the problems on hand will require it.

Our object consisted in examining closely and broadening the collection of both field and local data (Mogadiscio) as well as in gaining knowledge first of all of some little known facts, by making use of a general hydro-geological diagram:

1) Presence of many localized springs (Bud Bud, Gorof, Waxbo, El Dah and Jexan).

2) Evidence of a confined artesian aquifer in two wells South of Bud Bud (Ubadheere and Calcad wells).

3) A fresh water aquifer in alignment between El Dere (Ceel Deheere) and Calcad-Ubadheere (Kulmiye's Aligmment).

4) Difficulty when ascertaining fresh water resources in certain areas (Dhalwo) inspite of existing water wells in neighbouring parts.

Previous Investigations

When approached in the modern sense the basic Somali hydrogeological research was done by C. Wilson (1958) though the studies conducted by J. A. Hunt (1944-50) and W.A. Mac Fayden (1933-54) in the former British Somaliland must not be forgotten considering their scientific accuracy and the number of original data which had been collected and listed. Wilson divides the Somalian territory into 10 hydrogeological provinces of which he evaluates the characteristics of recharge und the yield. The paper contains other useful observations on the degree of groundwater salinity. Wilson's table correlating electrical conductivity (EC) and TDS is general consulted. Moreover it lists a remarkable number of the Country's water resouces with hints for their develpment and maintenance.

Besides G. Wilson C. Faillace's studies pf the Shabeelle Valley (1960-64) are to be remembered showing his vast experience and deep knowledge of the Country.

With particular regard to the Galgaduud and Mudugh there are notes by A.P. Popov and A. L. Kidwai (1972) in the report made under the patronage of the United Nations. The greater part of outcrops on the Mudugh Plateau is attributed to the "Mudugh-Merca Suite" (Miocene) having a top cover of well cemented eluvial-deluvial formations. The truly very accurate 1:1.000.000 hydrogeological map with certain faults on a regional scale drawn from ample geophysical survey operations for oil research is the most reliable document on tectonics. One will appreciate the importance of those great faults for hydrogeology as well. Of identical importance also is one of the enclosed

geological cross aection (No. II-III from Obbia to Yesomma), the sketch map showing the conductivity of the ground waters on a 1:4.000.000 scale and the list of wells for 12 of which the stratigraphy shown has been used. Popov and Kidwai mention an important aquifer in the MudughMerca series lying at a depth of 40-60 meters having 2÷4 g/l TDS (Total Dissolved Salts).

The Paleocene deposits (Yesomma Sandstone) are said to be considerable practical value, too, just to mention the Bulo Burti, Mataban and Mogocori wells. The authors believe that the ground waters of the Mudugh Plateau are of considerable importance in relation to the Country. The region is furthermore one of the provinces of which hydrogeological mapping was done by the above authors, bearing the Number 8. The coastal area, on the other hand, makes up Province No. 9 showing an increase of mineral particles depending on depth. That this could be so is easily understood considering the inevitable sea waters intrusion. Pratically speaking, these are the only data of a certain importance we have on the Galgaduud-Mudugh region.

GEOLOGY

On the 1:2.000.000 geological map of Ethiopia and Somalia prepared by geologist and paleontologists of Florence University (CNR 1973) the region under survey is almost entirely covered by evaporitic lithotypes (anhydrites, gypsum, dolomites, clay) of the Taleh Evaporites of the Lower and Middle Eocene. These are followed by the massive biogenic Auradu Limestones (Upper Cretaceous, Lower Eocene) forming a 2 km wide belt in that area and extending from Dh/Mareeb-El Dere to Hareeri Cali with the tops covered by eluvial-colluvial Pleistocene and deposits of more recent formation. Towards the Shabeellee Valley outcrops of Ferfet Gypsum (Cenomanian) are met in a normal stratigraphical succession as well as the Belet Uen Limestoine (Upper Cretaceous). Running from the Somali-Ethiopian border near Ferfer, the formation consists of a narrow belt terminating abour 2,5 km south of Belet Uen below shelly limestone together with some sandstone of the Belet Uen Formation. These limestones form a belt as well thinning out towards the south and disappearing about 1 km from Bulo Burti along the left side of the Shabellee Valley. The maximum width of the Ferfer outcrop is approximantely 1,5 km. The following 1:1.000.000 scale geological map of the area between Juba and Webi Shebeli Rivers which had also been prepared by the geologists of Florence University (1980) does not differ from the previous one, at least in the area with which this work is concerned. The enclosed descriptive notes con-

tain more precise chronological references, i.e. stratigraphy, without changing the picture of the mapped litho-stratigraphical units though.

To this end the stratigraphy of the Marai Ascia well No. 1 has been defined as follows:

a) Surface (+ 353 m) t 114 m:	Merca-Somal undifferentiated (Miocene-Oligocene)
b)-114 m to - 171 m:	Aurada Formation (Paleocene)
c)-171 to - 247,8 m:	Unnamed Formation
d)-247,8 to - 456 m:	Sagaleh Formation (Palocene)
e)-456 m to - 610,8 m:	Yesomma equivalent (Upper Cretaceous)
f)-610,8 m to- 1147,8 m:	Belet Uen equivalent (Upper Cretaceous)
g)-1147,8 m to - 1855,5 m:	Cotton Formation (?) (Lower Cretaceous)
h)-1855,5 m to - 2022 m:	Gabredarre Formations (Upper Jurassic)
i)-2022 m to - 2637 m:	Uarandab Formation (Upper Jurassic)
j)-2637 m to - 4050 m:	Hamanlei Formation (Middle Jurassic)

In the Tertiary of the Benadir, Hiiraan and Mudugh-Galgaduud Region however the following correlations are made between the stratigraphy of coastal oil wells and the outcrop series (by courtesy of Prof. G. Piccoli, Padua University):

Formation of Coastal oil Welles	Age	Central Somali Outcrop Series
Merca Formation	Present to Upper Miocene	
Somal Formation	Miocene to Oligocene	Hafun Formation
Obbia Formation	Upper Eocene	Karkar & Gumaio F.
Scebel Formation	Upper & Middle Eocene	Karkar & Gumaio F.
Coriole Formation	Middle to Lower Eocene	Taleh Evapotities
Marai Ascia Formation	Lower Eocene to Paleocene	
Sagaleh Formation	As above	Auradu Limestone
Yesommùa Formation & transitional suite	Paleocene & upper Cretataceous	Yesomma sandstome
Gumburo Series	Upper Cretaceous	Bele Uen Limestone

As had already been pointed out, the kind of stratigraphy Popov and Kidwai had suggested with clear reference to the studies by V.N. Kozerenkc and others, though being different, in many ways tallies with field evidence. The Mudugh Plateau is said to be taken up to the greater extent by the lithotypes of the Mudugh-Merca Suita which are distinct by one lower and one upper sub-suite. The Lower sub-suite is built up by products of basalt weathering and features sands, calcareous clay and marl with big interbeddings of sandstone, calcareous marl and gypsum having 38-60 m total thickness; the outcrop occurs in local depressions.

The upper sub-suite is mainly composed of concealed clear calcareous crystals with a mixture of sand. The limestone is normally covered by well cemented eluvial-deluvial deposits having an overall thinckness of 18-20 m.

The Mudugh-Merca Suite is attributed to the Miocene period; though the hydro-geological map nevertheless bears different marks such as proluvial, deluvial, eolian and marine sediments of the Pliocene-Quaternary; along the coast of the Indian Ocean Eolian and marine deposits are likewise shown , consisting of dunes, sand bars and reef formations. Starting from Belet Uen to Bulo Burti the mapping concerns the Belet Uen Suite (Upper and Lower Cretaceous) while the Yesomma continental sandstones are supposed to occupy the sector of the Mudugh Plateau which is not involved by marine retreat. Added to this, going by the lithological sections of tube-wells, the Daban Series (see W.A. Mac Fadyen and J.A. Hunt) subdivided into Upper Daban (conglomerates and sandstone) and Lower Daban (sandstone, siltstones, marls) is clear recognizable. Nevertheless, the deficiency of paleontologycal data is an abvious handicap. In this connection only the lithologycal data of deep water wells will be of importance as they confer a satisfactory geological picture of the Mudugh Plateau when in correlation with our field research (Map. Nr. 1 and crossection).

Consideration on the stratigraphy of tube wells

The inspections concerns the stratigraphy of 35 water wells having a bore depth of about 70-100 m and beyond; all the data on 15 ot them were collected at the Mogadiscio Water Agency, the description going from West to East and from North to South.

Db/Mareeb (two wells for water supplv)	255 m SL	Well No. 2: 140 m deep
Guriceel	249 m SL	One well 66 m deep
Matabaan	245 m SL	One well 240 m deep
Fer Fer	240 m SL	Two wells 30 & 22 m deep
El Bur (Ceel Bur)	175 m SL	One well 122 m deep

A further two wells for oil research were drilled to about 2400 m depth in the Dh/Mareeb area. Dh/Mareeb well to No. 1(250 m Sl) passes through about 150 m of sands, clays and Quaternery breccia, followed by about 200 m of sand and limestones belongin to the Auradu Formation, the Yesomma Formation with basalts and lastly, by the Gumburo Series. Dh/Mareeb well No. 2 (320 m SL) passes through approximately 120 m of clays, sands and limestone attribuited to the Quaternary,followed immediately by the sands (and sandstone?) of the Yesomma Formation and the Gumburo Series. No signs of the Taleh Formation were met in those two wells.

The drilling for water supply of Dh/Mareeb well No. 2 resulted in:

From 0 to 50 m	Limestone clays, marl and sands outsandingly brown coloured alternating with grey
From 50 to 102 m	Gypsum with thin interbedding of clays sand
From 102 to 140 m	Brown and grey limestones

Dh/Mareeb well No 3:

From 0 to 34 m	Gypsum and light limestone
From 34 to 100 m	Limestone and olivinic basalts
From 100 to 118 m	Yellowish limestone and sand

The presence of gypsum and basalt stones rather facilitates assignins the stratigraphy; the Mudugh-Merca Suite lithologies are in fact recognizable (Miocene: Popov and Kidwai) covering the basalt stones of the "Trap Series" as called by British geologists (Paleocene-Miocene), the latter overlaying the limestones of the Auradu Suites (Paleocene). In fact, when drilling oil well No. 1 at Dh/Mareeb the Auradu Formation was encountered at depths rangin from 120 m to about 350 m; the basalts with the Yesomma Sandstones are shown at an approximate depth of 500 m. At a distance of approximately 60 km one encounters the stratigraphy of the 66 m deep Guriceel well showing a fairly monotonous sequence of light-grey or light-brown sand and sandstones which are related in all probability to the Yesomma Sandstone (Paleocene).

Further to the West, about 50 km from Guriceel, the 240 m deep Matabaan well-shows an upper sub-suite prevailingly consisting of brown, yellowish and grey sandstones and sand followed by a lower essentially calcareous sub-suite with little sandy strata. The former sub-suite is 90 m thick, the latter about 120 m whereas passing strata of intermidiate lithologies take up a thickness of approximately 30 m. In our view the Yesomma Sandstones (Paleocene) were preforated eventually reaching the top of the Belet Uen Limestone (Upper Crettaceous). At Ferfer, on the other hand, the wells mentioned by Popov and Kidwai have crossed the Ferfer Gypsum (Cenomanian).

When proceeding from weast (Dh/Mareeb) towards East (Ferfer) along a front of approx. 160 km and 10 m only of difference in height, one arrives from the Quaternary-Miocene at the Upper Cretaceous; the fault between Matabaan and Ferfer running approximately in direction North-South according to geophysics as has been indicated in the Hydrogeological Map by Popov and Kidwai, therefore assumes some considerable importance.

From Belet Uen (Beledweyne) to El Bur (Ceel Buur) and as far as Xaraardhere there are very few significative stratigraphies only. At El Bur only a deep well (122 m) is given by Popov and Kidwai having a stratigraphy made of a sequence of gypsum, sand and red and reddish grey clays up to 103 m followed by basalt right down to the bottom of the well. In our opinion, identically as in the case of the Dh/Mareeb wells, we are dealing here with the Mudugh-Merca Suite superposing on the basalts of the "Trap Series" (Paleogene-Miocene). Exactly because of the presence of the basalts on the well bottom makes us doubt that the lithotypes can be allocated to the Taleh Formation as stated by Popov and Kidwai. On the other hand the Italian geologists date the volcanites of the Somali Plateau back from the Pleistocene (and preesent) to the Oligocene (Miocene doubtful); these volcanites are anyway much younger than the Taleh Formation (Lower to Middle Eocene) an cannot remain below. In any case the "basalts, 79 m thick, over lie limestones of the Auradu Suite (Paleocene) and are overlain by Miocene rocks in the Mudugh area" (see Popov and Kidwai).

Well stratigraphies can ben found further South in the following localities.

When drilling the two wells at Bulo Burde a sequence of grey limestone mixed with brown clay in the upper part was crossed as well as another sequence mainly formed by white, lightbrown and light grey sand in the lower part; we believe that these belong to the Belet Uen

limestones (Upper Cretaceous). During drilling operations of the Ubadheere well about 100 km East of Bulo Burde black, darkgrey light-grey and pale basalt as well as loam and hard serpentine (?) with thin layes of limestone and sand were met at depths going from 120 to 123 m. On top of such basalts a monotonous sequence of limestone (prevaillingly), sands and clays can be found whereas light-brown or light-grey and white sands exist below depths from 136 to 147 m. On the analogy of what has been said about the El Bur well we are of the opinion that the Ubadheere well crossed the Mudugh-Merca Suite and the "Trap Series".

Bulo Burde, 132 m Sl	Two wells, 60 and 72 m deep
Aadan Jawal, 153 m SL	One well 50 m deep
Ubadheere, 116 m SL	One artesian well 147 m deep
Galcad, 119 m SL	One artesian well 70 m deep
Jacaar, 128 m SL	One well 85 m deep
Gal Haareri, 194 m SL	One well 126 m deep

At the Aadan Jawal well white and grey limestone were met nearly exclusively according to the findings of Popov and Kidwai and going by the survey od Italian geologists, it could be a case of passing from the Auradu Limestones to the Yesomma Sadnstones (Lower Eocene to Upper Cretaceous-Paleocene).

A simple stratigraphy split into two sequences, i.e. an upper sequence of 40 m thick clayish sand and clay and a lower sequence right down to the well bottom of sandy fractured limestone, is caratcteristic for the Galcad well. There are no markers of correlation; owing to the analogy with the Ubadheere well some 24 km away, in our opinion this belongs to the Mudugh-Merca Suite.

Only incomplete data have been supplied by Popov and Kidwai on the Jacaar and Gal Haareeri wells. The initial sequence above 40 m is formed mainly of limestones, marl and marly limestone of white reddish-white and grey colour, and being fractured, porous of soft and sami-crystalline, at times. The presence of quarzite coming in rounded grains and boulders of limestone and conglomerate (calcareous and reddish-white crystalline calcium carbonate geodes) at 3 and 15 m depth in the Jacaar well was particularly interesting (see the Generalized Stratigraphic Sequence of Popov and Kidwai). This sequence could reasonably be referred to the Dubar Serie (Mac Fadyen) or of the Upper Daban Serie (Miocene-Pliocene ?), i.e. a formation immediately above the Mudugh-Merca Suite.

About 30 km to the South towards the coast of the Indian Ocean, there is a row of the following wells:

El Bilal	130 m SL	One well 55 m deep
140 km	128 m SL	One well 102 m deep
Guulane	180 m Sl	Two wells 216 & 228 m deep
Hareeti Cali	112 m SL	One well 125 m deep
Cawsweyne	121 m SL	One well 150 m deep
Marai Ascia	347 m SL	One oil well more than 4000 m deep

El Bilal village is situated about 40 km south of Bulo Burti along the Shabeelle River. The hole, 55 m deep, crossed sands, limestones and marnes; we can also find basalts between 19 and 28 m of depth as well as in the tube bottom. The attribution of a lithological sequence is not easy; we think basalts of the Trap Serie (Lower Neogene-Paleogene) are involved. They interested the Yesomma Sandstone (Paleocene) in analogy with the Hydrogeological Map of Popov and Kidwai and with the hole to the 140 km. We doubt the Upper Daban Series is involved; in this case these deposits might be correlated to the ones founded in the upper part of the well to the 140 km and of Maaddei Uen one.

The data on the well at the 140th kilometer stem from C. Faillace; this well lies on the road Bulo Burte-Mahaddei Uen about 30 km to the North of the latter place. During the drilling operations about 50 m of reddish gypsiferous sand, limestone and white or brown coloured gypsiferous clay were crossed, followed by marls and dark brown and reddish sands extending right down to the well bottom; C. Faillace tentatively allocates the sequence crossed to the Middle Cretaceous period. According to the geological map plotted by Italian geologists iy might be the Mustahil limestone, but referring to the hydrogeological map drawn by Popov and Kidwai it could belong to the Yesomma sandstone (Paleocene). It will be clear that the initial 10-20 m of this and of all the other wells in the great valley of the Shabeelle River, consist of alluvional deposits becoming more and more important and getting thicker the nearer the river gets to the coast of the Indian Ocean.

In and near the villagee of Guulane we come across two well stratigraphies, the place being about 30 km south od Aadan Jawal. The drillings have crossed a relatively uniform sequence which can decidelly be referred to the Yesomma Sandstone (Paleocene); in fact findings resulted in brownish or light grey sands with a few interbeddings of limestones, reddish sandstone and clays.

The Hareerri Cali well well about 15 km South-East of Ubadhere and 24 km South-West of Galaad crossed a uniform sequence of sands and gravels, the latter found at depths ranging at 3 m, from 6 to 12 m and lastly, from51 to 72 m. The sands are described as being medium to coarse, with angles to rounded, calcareous and coloured light-brown, slightly orange, light-grey or buff, Going by the description it is thought to be a matter of the Upper Daban Series (Miocene-Pliocene ?).

As particolarly interesting appears the well stratigraphy of Cawsweyne to be, a village about 80 km E-NE to Hareeri Cali and approximately 50 km SW of Marai Ascia 40 km off the coast. Drilling has passed through two clearly distinct subsuites, i.e. the upper suite 69 m down from the level consisting of gravels and sands in a subordinate way, the lower almost exlusively formed by limestones and dolomitic limestones at 69 to 150 m depth. Gravels and sands of the upper suite are described as being coarse to medium (gravels) and going from very fine to fine and medium for sands. The colour is light always: light grey, brownish or buff. Gravels are described as strongly or poorly cemented. In our mind no doubt can exist in allocating this sub-suite to the Upper Daban Series. ("Upper Conglomerates" according to Italian geologists).

Passing to the lower sub-suite takes place through a seam of white, light-grey, pale, very hard, dense and slightly sands limestone not greatly different from the material at greater depth; very little sand and clay will be found between 105 and 108 m depth. 144 to 150 m drillings come to an end at dolomitic limestones being dark-grey, grey-yellow-pink, slightly sandy, crypto-crystalline, hard and porous. Such sequence could correspond to the Auradu Limestone (Lower Eocene to Upper Cretaceous). A similar allocation would tally with the stratigraphy of the Marai Ascia well where an undifferentiated Miocene-Oligocene Merca-Somal Formation is met starting at 347 m SL to about 114 m depth. A calcareous sequence of the Auradu Formation (Paleocene) will be met further down, however. It should be noted though that the Cawsweyne well is topographically about 200 m lower than Marai Ascia and that geophysic research points to a large fault running parallel to the coast at about 27 km from the sea. Drilling has probably crossed the Upper Daban Series whereas the limestones below belong to the lower member of the Mudugh-Merca Suite or to the Dubar Series: we believe the latter to be the more probable hypothesis.

Between the above described area of wells and the coast of the Indian Ocean no significative stratigraphies were encountered. Popov

and Kidwai have assessed those refering to the following wells:

Mahadday Weenye	123 m Sl	One well 115 m deep
Bio Caaddo	180 m SL	One well 84 m deep
Acab Duo	175 m SL	One well 140 m deep
Mir Nagot	160 m SL	One well 108 m deep
Ris	168 m SL	One well 108 m deep
Masjid Ali Gudud(Lebi Awee)	65 m SL	One well 102 m deep
Run Nirgood	80 m SL	One well 105 m deep
Joowar	110 m SL	One well 112 m deep

The Mahadday Weenye well near Shabeelle is passing through dark-brown, light-brown, greyish and gypsiferous clays and reddish sands; another passage from 45 m downward predominantly concerns calcareous pebbles, gradually increasing to 7-8 mm, and an abounding number of gypsum crystals, calcareous marls, whitish or reddish, thinly bedded siliceous sands and some pebbles. The lithologies all around would point to Yesomma Sandstone, thus decidely taking up the valley floor of the Shabeelle.

Bio Caaddo: brown clay, sandy limestone, reddish and greyish compact conglomerate (the constituents of which derive mainly from Belet Uen Limestones and Yesomma Sandstones). We believe that the well has crossed the river alluvions for at least 50 m as well as the products of the marine retreat (Upper Daban Series).

Acab Duo: marly sandy clays, siliceous sands, coarse, whitish sharp-edged calcareous gravel, fairly rounded; sandy clay with frequent gypsum crystals, siliceous sands. Brown sandy clay with a few calcareous pebbles. These deposits are believed to represent the Upper Daban Series.

Mir Nagot: marly clay, reddish sandstones, siliceous and calcareous sands; ligh-brown marly sandy clay with a few gypsum crystals. Greyish hard compact marls: calcareous nodules and detritus (conglomerate ?), greyish and reddish; greysh marly limestone and brownish calcareous marls: whitish marly limestone. To the bottom: calcareous detritus (conglomerate ?) and small pebbles mixed with reddish marly clay. Such sequences could refer to the Mudugh-Merca Suite.

Ris village lies about 40 km East of Bio Caaddo and approximately 25 km distant from Caadale. During drilling operations the following were passed through: sandy porous limestone nodules cemented by calcium carbonate with thin intercalations (surface to 33 m depth); these are followed by fine to medium grained white or reddish sands with

interbedding of sandstone, presence of well preserved foraminifera. In our opinion such sequence may be attributed to the (Middle ?) Daban Series or the Mudugh-Merca Suite.

The well of Masjid Ali Gudud (Lebi Awee) passed through 51 m of sandy soft limestone with some fragments of gasteropods, sands and loam. Finely grained sands with marine micro-fossils were found at 99 to 102 m: Mudugh-Merca Suite and/or (Middle ?) Daban Series.

The well of Joowhar (112 m deep) crosses alluvial and proluvial deposits of Shabeelle River and lithological sequences of the Upper Daban Series: pebbles, sands and gravel, clay marly, silty red brown.

The well of Run Nirgood is situated about 90 km NE of Ris village 30 km off the coast of the Indian Ocean; the stratigraphy is very alike to that of the Ris well showing reddish and siliceous sands. Interesting to note is the white porous limestone with gastropod and foraminifera fragments at depths between 3 and 54 m. Deeper down siliceous subrounded sands with intercalations of sandy limestone, particular in depths from 66 to 79 m and 93 to 99 m are encountered; the size of the sands increases with depth. We believe that this sequence should be assigned to the Daban Series as well. However the fact remains that the passage between the Obbia Formation has been indicated for the Obbia subsoil at 180 km towards NE without its lateral and vertical relations with the Daban Series being clear at all.

After all, starting towards East from the Shabeelle Valley there is a passage beginnning at the oldest formations to those of more recent periods while the sequences of the Daban Series (tha Hafun Series and the "Upper Conglomerates" broadly speaking as well as) become more and more important covering an approximate 30 km belt caused by the subsidence of the Plateau blocks. Thus the innermost areas are taken up by the oldest formations (Ferfer Gypsum and Belet Uen Limestone) even though the position of the Mudugh-Merca Suite is of primary importance as for outcrops. The Taleh formation is to be mapped in an entirely different way, likewise as part at least of the Aurady Limestone. Very little outcrop can be noted on the other hand that could be considered significant: the landscape shown nothing but a monotonous succession of slight undulations (Quaternary and Recent) while the bottom of the tracks consists of reddish sandy ground, caliches or yellowish limestone blocks. Sufficiently reliable informations in such conditions can be gained only from the stratigraphies of the wells as aerial photographs or satellite shots may not help too much.

Among the data which came to light trough stratigraphies of the tube-wells, there is that regarding a remarkable diffusion of deposi-

ts being of a much more recent formation than had been assumed. It is a question of products resulting from marine retreat which could generally be attributed to the Mudugh-Merca Suite. In certain cases the relatively very accurate lithological descriptions also seem to point to formations such as the Dubar Series and Middle and Lower Daban Series, mentioned on the previous pages in a hypothetical way. However we think that in the future the geologists will be able to divide the Mudugh-Merca Suite as they have done for the Duban Series. In that case, the two Groups of lithostratigraphic unit will possibly prove to correspond in many aspects.

Furthermore, our lithostratigraphic values are based, as far as chronology is concerned, on the Marai Ascia and Dh/Mareeb oil wells. Particularly, the Taleh Formation (Evaporites) has not been found in the two wells of Dh/Mareeb, because after Quaternary we immediately find the Auradu Formation (in well no. 1) and the Yesomma Formation (in well no. 2. Auradu Formation is found below 100 m depth and it is no more distinguishable in Dh/Mareed no. 2. The basalts found at approximately -500 m depth in Dh/Mareeb no. 1 could indicate that not all sands and sandstone found between approximately -270 and -700 m belong to the Yesomma Sandstone. We also notice that the "Auradu" limestones are found only between -230 ad -270 m. We think that there is room for the Mudugh-Merca Formation.

HYDROGEOLOGICAL SCHEME

Field observations, the location of tube and dug wells and the rather dense stratigraphic when referred to certain areas of the Country, allow one to arrive at consideration of a general nature. Since there are relatively rich and diffused water resources in the Galgaoud subsoil, the productivity of all dug well is expected to improve greatly if adequate arrangements are made; the real problem is not so much that of quantily but far more of quality. Research should therefore be directed to spots where the gypsum does not deteriorate the quality of the water as depth of drilling does not necessarily mean good water quality; there are most significant cases for a relatively restricted area.

Between Gal Hareeri, Marai Ascia, Dhalwo and Xarardheere, for instance, even on a front of scarse 80 km, the situation differs considerably. The 127 m deep well of Gal Haareeri yields sufficiently fair water (EC = 4700 mmhos.cm = 2,7 - 5 g/l of TDS); seven water supply wells were drilled to supply the drilling and personnel requirements of Marai Ascia No. 1. Two wells were dry and therefore abandoned, the

other five produced salt water for drilling purposes only whereas drinking water was trucked in from El Dah.

The Marai Ascia wells are situated as follows: No. 2 about 1 mile East of the town of Gal Haareeri, No. 5 near the village of Ris which is about 30 km to the East of Gal Haareeri. Well No.1 and 3 of 104 and 164 m depth, respectively,were abandoned; wells 2, 4 and 5 having an approximate depth of 251, 264 and 211 m, respectively, yielded water which 13,4 - 9,5 - 10 ppm NaCl salinity. The 82 and 85 m deep wells No. 6 and 7 near Gal Haareeri yielded water with 4,8 and 6,1 ppm NaCl salinity. In the Village of Dhalwo about 14 km West of Ris, two 205 and 150 m deep wells produced negative results. Along the road to Xarardheere there is the 15 m deep dug well of Deegan yielding very fresh water (only EC = 400 mmhos.cm = about 0,5 - 1 g/l of TDS). The Xarardheere plain with its approximately 15 - 18 m deep wells gives fresh groundwater (EC = 2200 mmhos.cm = 1,5 - 2 g/l of TDS). In our opinion exactly the less deep wells in the quaternary-pliocenic sequences are those that supply fresh water, but there is no reliance at all that they will last forever.

We shall now proceed to examine the groundwater resources according to their distribution in the subsoil, by summarizing the stratigraphical features of the drill logs.

When examining this table and the distribution of the data available on all wells, it can be stated that the Yesomma Sandstone represents the most appropriate formation to yield fresh water; in our view the Upper Member of the Mudugh-Merca Suite but first of all, the Dubar Series is rich in water resources and fresh water as well. Aquifers run in sands and fissured limestone wereas the sandstone will yield little water only because of its low effective porosity.

All the same a survey of Distribuction of Electrical Conductivity (EC) in shallow groundwater induces furthere thought and comparison (Map No. 2). The map was drawn up by uniting all available data, i.e. those collected by ourselves, Popov and Kidwai and C. Faillace as wall These data nearly always refers to shallow groundwater; when referring to the few deep wells (some twenty for more than 140 wells under survey), one must be aware of the fact that their passage concernes a single aquifer only with no mixing of chemically differentt water as consequence. An exception is the well situated at km 140 where fresh water was found (EC = 4000- after a shallow aquifer (EC = 10.000) had been isolated as referred to by C. Faillace. Thus any of the errors that have been committed represents something of little importance in relationship to the scale we were compelled to use for the map.We

Well	Total depth	Geological sequence
Dh/Mareeb No.1 and 2 (oil wells)	2300-2400	Quaternary(?) to Auradu-Yesomma and Gabredarre F.
Guriceel	140-118	Mudugh-Merca S.-"Trap Series" Auradu M.
Matabaan	66	Yesomma Sandstone
Dh/Mareed No.2 and 3 (water wells)	240	Yesomma Sandstone-Belet Uen Limestone
Ferfer (III)	22	Ferfer Gypsum
El Bur	122	Mudugh-Merca S. - "Trap Series"
Bulo Burde No.1 and 2	60-72	Belet Uen Limestone
Aadan Jawal	50	Auradu Limestone - Yesomma Sand.
Ubadheere	147	Mudugh-Merca S. - "Trap Series"
Galcad	70	Mudugh-Merca Suite
Jacaar	85	Upper Daban Series - Mudugh-Merca Suite
Gak Harceri	126	Upper Daban Series - Mudugh-Merca Suite
El Bilal	55	Upper Daban S. - "Trasp Series" Yesomma Sandstone
Km.140	102	Upper Daban Series - Yesomma S.
Guulane No.3 and 1	216-228	Yesomma Sandstone
Hareeri Cali	125	Uppere Daban S.-Mudugh Merca S.
Cawsweyne	150	Upper Daban Series - Mudugh-Merca S. - Auradu L. (?)
Marai Ascia (oil well)	4000	Merca-Somal Formation to Hamanlei F. (Middle Jurassic)
Mahadday Weeyne	115	Alluvial Sed.-Upper Daban Serie-Yesomma Sandstone
Bio Caaddo	84	Upper Daban Series (and Proluv. Alluvial sediments)
Acab Duo	140	Upper Daban Series
Mir Nagot	108	Mudugh-Merca Suite
Ris	108	(Middle?) Daban Series - (Mudugh -Merca Suite)
Run Nirgood	105	(Middle?) Daban Series -(Mudugh-Merca Suite)
Masjid Ali Gudud (Lebi Awee)	102	Mudugh-Merca Suite - (Middle ?) Daban Series
Joowhar	112	Alluvial Sedim. - Upper Daban S.

therefore have used the 1:2.000.000 topographical maps. Edition 4-AMS and 6-DMA (Sheet 21 compilet in 1968, and Sheet 25 of 1978) purposely enlarged as well as the old 1:1.000.000 Italian maps which still are very useful because of the toponymy. The localities of tube and dug wells are given according to the above topographical indications, probable cause uncertainties and of the more noteworthy errors. The EC distribution was done by modifying the table G. Wilson had suggested by way emphasizing the fresher waters in respect of the more mineralized ones.

The minimum EC values (400 - 1500 mmhos.cm) corresponding to a TDS lower than or equal to 1,3 g/l are in relation with two hydrogeological structure. The first structure sets the limits of shallow basin with 10 - 15 m static level) in quaternary of Pliocene-Miocene aquifers in which the precipitation waters may seep into the suboil insofar as their downflow to the sea is prevented by the dunes. The fresh water found in the villages of Dumale, Miliago, Mirron and Deegan West or NO of Xarardheere is connected with this type of hydrogeological structure. A typical case is that of Deegan: water in the well at - 12 m, T° 27°, EC = 400 mmhos.cm, quaternary, dunes wandering down to the sea (Xarardheere). Anotherr interesting aspect is that of the Bio Addo fresh water (EC = 1500 mmhos.cm) surrounded by higly mineralized water: Uar Dagagh EC = 13000, Acab Duo EC = 12000, Bar Cadune EC = 11000, Ali Dere EC = 8000, Ris EC = 15000, Addo Uè EC = 5000. Extremely fresh water is also found along the coast, i.e. at Cadaale ED = 1400 - 2000 mmhos.cm, El Igo EC = 1500. We are dealing in these cases with a thin fresh water veil floting on the saline layer prior to getting dispersed in the sea: the wells are hand dug at distances ranging within a few chilometers from the coast line. Regarding the quality of the coastal waters it should be remembered that it may vary not only during the season, but also according to the cycle of the tides; drawing of water according to the season, but even the hour when the drawning takes place will become important.

A second hydrogeological structure showing very fresh water is given by the alignment El Dere-El Dah-Dab Ugaz-Bud Bud-Galaad-Ubadheere wich Gen. Xuseen Kulmiye Afrah had pointed out to us according to his knowledge of traditions cultivated by the people there and which we have therefore named "Kulmiye's Alignment". It decidedly tallies with a belt of very fissured and karstic limestone which in our belief belong less to the Auradu Formation, but far more to the Upper subsuite of the Mudugh-Merca Formation or the Dubar Series.

The following are the data collected or which were available:

El Dere: Dug well	Static level 8 m		T°water 29°	EC 1300	mmhos.cm
El Dah: Spring	"	" 0,5	"	29° "	1500	"
Jexan: Spring	"	" 0,5	"	27° "	2000	"
Bud Bud: Spring	"	" 0,3	"	30° "	1500	"
Damairor: Spring	"	" 0,4	"	30° "	1800	"
Calcad: Artesian tube well 70 m deep			"	28° "	2000	

It should be remembered that two additional springs are located in the Jexan-El Dad area along the road leading from El Bur to Maas, i.e. Wabo (EC = 4200, T° = 26,6°) and Gorof (EC = 3200, T° = 28°). About 25 km South of Gorof lies the El Afuen dug well (EC = 2800, T°= 27,8°) while the Dirri water shows EC = 3000 mmhos.cm. In other words, the very fresh or good quality water belt has an average width of about 30 km for 350 length through fractured cavernous limestone as in Gorof where it can be found at the bottom of a 5 m deep fracture. At Bud Bud the water issues through fracture of white limestone to form a lake of wifth that varies with the season to create a landscape of unbelievable beauty.

Between the areas of the springs - Bud Bud in 135 ù SL - and the two artesian wells of Galcad (119 m SL) and Ubadheere (116 m SL), there is a level difference of about 15 m. The aquifers feeding those wells are located through at by far greater depths as more than 60 m. The waters of such springs and of the two wells are very fresh, too, but, the are dug well carrying highly mineralized waters only a few kilometers south of Galcad and Ubadheere, i.e. Mahab (EC = 10.000), Nauir (EC = 15.000), Aadan Yawal (EC = 6000), Gal Gal (EC = 6500) and Hareeri Cali (Ec = 7000). The spring waters are therefore bound to a water circulation differing from that of the surrounding wells, all the more so as Popov shows and EC value of just 400 mmhos.cm for the Dab Ugaz well situated a few kilometers away from El Dah. Therefore the fresh water belt represents a hydrogeological element of primary importance, not to be separated from the hydro-geological aspect of the two artesian wells of Ubadheere and Galcad. We believe in the very important part played by the fault which had been assessed through geophysical studies as running from the 140th kilometer north of Mahaddei Uen as far as Gal Tardo-Bud Bud-El Bur-Emedle. This fault causes a fracture of the limestones and favours the upwelling of the underground waters, somethings which is produced artificially by drillings. The fact that both the dug wells and tube wells to the side

and south of Kulmiye's Alignment yeld highly mineralize water proves that the fresh waters are well localized and deep.

We shall now examine the distribution of the maximum EC values ranging from 7500 to more than 10.000 mmhos.cm. Such values are mainly concentrated in wells along the Indian Ocean coast and the second great fault assessed by geophysical research, i.e. the one rising from Joowhar towards Xarardheere and keeping approximately parallel to the coast at an average distance of 30 km. From the viewpoint of the hydro-geologist the task of this fault is entirely different from the fault mentioned in respect of the spring area.

Starting from the Shabeelle Valley towards NE there is, in fact, an alignment of wells holding waters of such intense mineralization to become pratically unserviceable: Jiliale (Jameeca) EC = 7000 mmhos.cm, Bar Codune EC = 11.000, Uar Dagh EC = 13.000, Acab Duo EC = 12.000, Martugo EC = 8000, Ali Dere EC = 8000, Ali Ued EC = 29.000, Run Nirgood EC = 16.000, Agar Gul EC = 8000 and El Bur Dainer EC = 9000. Salt waters in direction of the coast cover a stretch even of many kilometers; for instance, the Raga Elle (EC = 16.000) and Ris wells (EC = 15.000) are found about 25 km SE of Acab Duo. In our opinion the great fault of Joowhar-Xarardheere has caused the subsidence of a large sedimentary base-plate, thus favouring deposits of Miocene-Pliocene Evaporites; tus the Mudugh-Merca Suite would contain predominently chalky lithotypes. In addition there is the formation and extension of saline and alkali sols, a typical problem in arid and semi-arid areas.

It is known (see i.e. W.T. Chow) that the presence of salts in water is due to chemical decomposition and physical weathering of soluble constituents of the minerals in soils and rocks.

Moreover, salts of oceanic origin can be deposited by rain so that in some areas most of the salt now present in the soil, seem to be the result of accumulated small annual amounts brought by rain over a long period.

Anyway, in humid areas, part of the salts are carried downwards by rain into the groundwater and partly carried by streams to ther Ocean. On the contrary, in arid regions as a consequence of light rainfall and high evaporation rates, leaching is usually on a small scale, so that soluble salts may not be carried far and therefore tend to become concentrated in groundater, soils and dry lakes.

In some arid regions, rather than by local salt deposits, large areas are effected by salinity to a slight extent only. Salinity problems arise only when a change occurs in the hydrological cycle (for

instance, due to removal of vegetation). Saline and alkali soil problems can often develop as a result of the irrigation of areas which may be non-saline and well drained under natural conditions, but may have drainage facilities inadequate to take care of the additional groundwater resulting from irrigation practice. In such conditions the groundwater level may rise to the root area, water may move up to the soil surface and as a result of evaporation, the salt content of the surface soil and of the soil water increases, affecting plant growth. The same problems arise if Drainage facilities are adequate, but insufficient irrigation water is applied to provide for the necessary leaching of excess salts. (Obviously, problems also arise from the direct effect of irrigation with too much saline water).

The solution to these problems is so important for the irrigation of arid or semi-arid areas, that the question of whether irrigation agricolture can perisist permanently is largely a matter of eliminating salinity effects. The fact however remains that a fresh water area exist along the Indian Ocean coast stretching from Ceel Guulo towards inland (Ghed Raran EC = 1600 mmhos.cm, El Mohamed Ali EC = 1000, El Dumai EC = 1800); though this area might also be an extension of Kulmie's Alignment, one should remember that nothing but salt water was found (EC = 16.000) at 105 m depth in the well of Run Nirgood, a village about 12 km to NO of El Mohamed Ali.

The coastal fresh water area stretches as far as El Endanane and Meghio Arai and gets linked up with the fair quality waters of the area Dusa Marb-El Bur-Cawsweyne-El Dere (EC = 4500 - 3000) as becomes very clear in the present case. Situations full of complexities are however not laking along the coast line which are due to erroneous drilling of wells and the progressive seepingin of salt water; different EC values therefore are applicable to Mereeg, El Cabobe (Ceel Qaboobe), Sememeio and El Dere, the latter name and those of other localities recurring various times to indicate places even very remote from each other. It may also be said that the quality of the coastal waters seems to worsen when proceeding North towards Obbia; fresh water wells and those containing salt water are found in Obbia, too.

When looking at the map and the distribution of the EC values it can be noted that peak values are mainly concentrated in spots with faults between the Shabeelle Valley and the Cawaaleguote area; in our belief this rock fracturation causes salt water to rise the surface.

When setting out from Mogocori-Bulo Burti the situation changes and fresh water will be found (probably from the Yesomma Sandstones) as far as Mataban; in this case the fault seems to bear no influence.

Another area having underground salt water is that of Marai Ascia, Ris and Dhalwo stretching towards North as a far as El Bur Damer (EC = 9000) and South along the coast to El Abdi (EC = 16.000). The best water quality belonging to the Xarardheere-El Ghan structure in probably found East of Dhalwo; this structure appears to have sufficient extension, and very fresh water (EC = 400 - 1500 mmhos.cm) are found inland at those localities we already have mentioned. As compared with that under survey, there is a marginal area around Garadi (EC = 140) and Marergur (EC = 1600) North of Dusa Mareb. A structure similar to that of Mataban seems to take shape, in this case North of Kulmiye's Alignment (see map no. 2).

The fresh water found in these wells could in fact be connected with that already mentioned of Miliago, Mirron, Dumale and Deegan by way of the Region known in the past by the old name of Habr Ghidir Soliman having dug wells with EC ranging from 3000 to 3500 mmhos.cm. This is the case of another hydro-geological structure which we intend to investigate in the near future as well. When observing the distribution pf the fresh underground waters, certain considerations of a geological nature may be made already now. Looking at the well stratigraphies, one notes the passage through the basalts of the Trap Series by the wells carrying the freshest water such as Well No.2 at Dh/Mareeb ("olivine-basalt with interbedding (?) of limestone and sands from 34 to 100 m"), the well at El Bur (from 102 to 122 m deep) and the Ubadheere well at a depth ranging from 120 to 123 m. As these wells are situated along Kulmine's Alignmentt, this formation could also correspond to that of a basaltic flow being buried to the greater extend. In fact, when observing the Italian 1:2.000.000 geological map a large outcrop of "Undifferentiated volcanics of unknown age and or litholgy" is shown around the village of Wender in the territory actually under Ethiopian rule; Wender is situated about 200 km North of El Dere, precisely along the run of Kulmiyes's Alignment. Viceversa the hydro-geological 1:1.000.000 map by Popov and Kidwai excluding territories beyond the frontier, points to a large outcrop of (Basalts in the basin of the Scebeli and Juba rivers" along the right flasnk of the Bulo Burti valley extending for about 80 km towards South at an average breadth of 25 km mentioned already, such basalts are attributed to the Paleogene-Lower Neogene ("Trap Series"). Neither in this case is there any concordance with the excellent colored map drawn by the Italian geologists showing for moree or less the same area two rather small outcrops only belonging to the already mentioned "Undifferentiated volcanics". No matter how, more or less volcanic outcro

ps with more or less noticeable alterations are present all over the region; loking at it from a hydro-geological point of view, we believe in a link between fresh water and volcanic matter. It should not be by a mere fluke, on the other hand, that fresh water is for instance found in the wells of El Bio (EC = 2800), CFeel Makoile (EC = 2800), El Cagnoueu (EC = 2500), El Midimal (EC = 2600) and elsewhere, i.e. exactly within the basaltic area to the right of the Sabeelle. When seen from the stratigraphical viewpoint the indication of such basalts in the wells could perhaps be of importance for the geologists as well.

In an identical way the distribution of the more mineralized water also creates an opportunity of discussing geological topics. We already mentioned the hydro-geological function of the great faults indicated by geophysics; the wells showing an EC greater than 7500 mmhos.cm are however concentrated in a region to the left of the Shabeelle going more or less from Joowhar to Cawaaleguote where the deposits of the Miocene-Oligocene marine retreat (Mudugh-Merca Suite Daban Series) should be encountered. The Upper Daban Series in particular contains important conglomerates ad sandstones, i.e. rock basins for underground waters, whereas the Middle Daban Series is characteristic because of its lagoonal facies (lithotypes capable of water mineralization). Sandstones, conglomerates and gypsum are still present in the Lower Daban Series serving as passage to the Karkar Formation. The undeground waters contained in the Mudugh-Merca Suite ought to be less mineralized being linked in particular to the solidy calcareous Upper Sud-Suite (springs of Bud Bud, Gorof, Jexan....). As the Lower Sud-Suite consists of even chalky lithotypes, it must be pointed out again that depth is no guarantee whatever for the quality of the under-ground water. Only if the Auradu Limestone or the Trapp Series or the Yesomma Sandstones can be reached and drilled - isolating at the same time possible water resources found at peak levels - will the water quality compensate the costs of deep drilling.

CONCLUSIVE CONSIDERATIONS

As the structure is made conspicuous by Kulmiye's Alignment, this is believed to be worth a more organic investigation, such as would be a deep geophysical survey and drilling two 150-200 m wells between Bud Bud and Ubadheere as well as a third well near El Dere; attention should be paid in the same way to te area NE of El Bur and to the Maas area.

The fresh waters not far off the coast similarly to those of the

Deegan-Dumale-Mirror-Miliago structure, create different problems as they are believed to be linked to shallow aquifers, though they may prove to be most interesting all the same. For a start a number of capacity tests of these wells should be carried out to get a first idea of the potentiality these aquifer posses. In case of positive results the existing wells could be improved by way of yielding a greater quantity of water. We believe that deepening of the wells should be convenient.

The problem created by the fresh coastal waters is different still; we already emphasized that the problem does not so much consist in discovering them, but far more in their protection. In this case the exploitation of the underground water resources is most delicate as it will be possible to proceed after a period of studies and tests only. The exploitation of the coastal fresh water resources however, which are very rich and widely distributed in Somalia - the shepherds have known this from immemorable times - require adequate protection against the flooding by salty marine and brackish waters of the transition zone. In fact, the thickness of the fresh water is generally limited to one or two meters at the most; continuous or excessive milking will inevitably cause a return of salty waters. There are various methods serving contemporaneously as means of enriching the underground water reserves, we would like to suggest a kind of future modus operandi, which we considere the most appropriate for the region

Our investigation should be considerted as an initial stage of the work we have in mind. It can however be said now that good quality water exists in Central Somalia, indicating favourable prospects for the people living in the vaious village whom we have met and who have always extended great and friendly hospitality to all of us.