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PRELIMINARY GEOHYDROLOGICAL SURVEY RESULTS OF
DOLOMITIC COMPARTMENT OF MOOIRIVER

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1. BACKGROUND

The present investigation of Mooi River Compartment forms an integral part of a comprehensive study of dolomitic areas of Central Transvaal (PWV complex). The Directorate of Geohydrology has been engaged in an evaluation of the water bearing properties and potential water supply of the Chuniespoort Group since early 1980. Large areas of dolomite, adjacent to the Johannesburg granitic dome, were explored as a possible source of emergency groundwater supply to supplement the surface water supplies which at the time were diminishing due to the severe drought of 1982 - 1985. The promising results that were obtained by Kafri (1986), Bredenkamp et al (1986) , Kok (1986), Leskiewicz (1987), Hobbs (1988) in the PWV dolomite and for the Ventersdorp to Lichtenburg dolomitic areas justified an investigation of the dolomite west of Holfontein up to Klerkskraal Dam. This area which is the subject of this report is named the Mooi River compartment.

2. INTRODUCTION

An investigation was carried out between January and April 1989 (24/01/89 - 26/04/89) on the hydrogeology of the Mooi River compartment. This compartment covering an area of approximately 1 000 km² comprises of 44 cadastral farms.

The area to the east of the Mooi River compartment called Holfontein compartment (see map 1.2) was surveyed by Bredenkamp and al (1986) and the western part was investigated by Erasmus (1967) and portion of the latter and by Polivka (1987).

The hydrogeological boundaries (refer map 1.1) of the studied area which will be discussed in more detail later on are the following:

In the north - Pretoria Group

In the south - Black Reef and Witwatersrand supergroup

In the east - Holfontein Dyke

In the west - Almore Dyke.

3. GEOGRAPHY

3.1 Geomorphological setting

The study area forms a part of Transvaal Highveld. The average elevation above the sea level is between 1500 and 1600 m. Most of the area and especially the central part is almost flat, only slightly undulating to the west. Broad, west-east orientated valleys follow the contact zones between different formations of dolomite. These valleys are practically dry and only carry surface runoff immediately following heavy rainfalls however the valleys stay wet and marshy for prolonged periods after the rainy season. There are two main north-south drainage channels. One is the Mooi River and

Klerkskraal Dam and this broad valley is the lowest, below 1500 m a.m.s.l. part of the area of the investigation. The other valley appears to be a less prominent waterless feature following "roughly" the Holfontein dykes system. (See Figure 2.1)

3.2 Climate

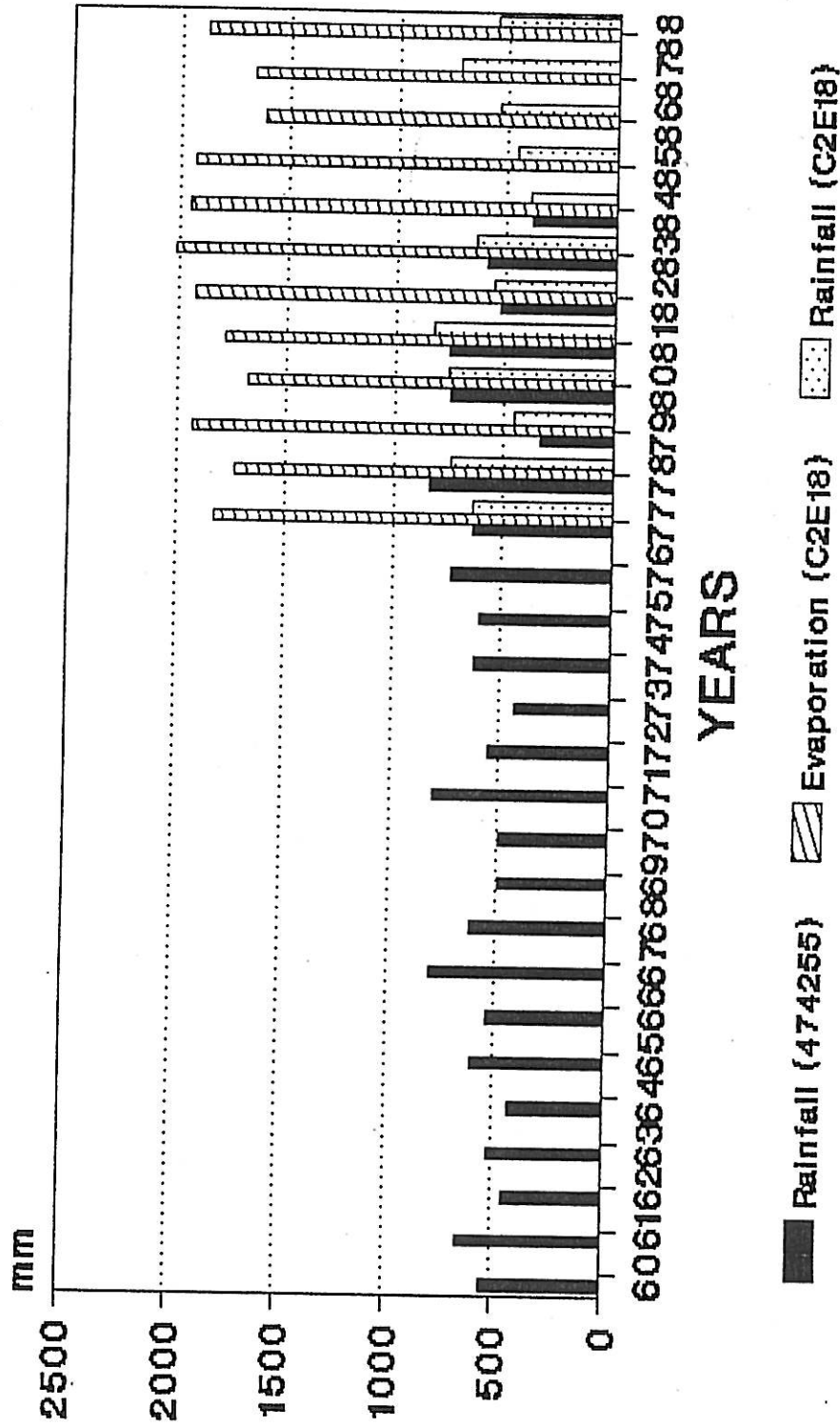
The average yearly rainfall for this area amounts to 606 mm (Polivka 1987). The rain mostly occurs during summer months and frequently in the form of thunderstorms. The daily and annual variability of the rainfall can be large.

The open surface evaporation measured from the evaporation pan of the Weather Station at Elandskuil Dam shows an average 1 900 mm per year (see figure 2.4).

3.3 Hydrology

The compartment has two valleys that provide possible drainage for surface waters. The one is a shallow depression only carrying water during heavy rainfalls. This valley might have been initiated by fault-dyke feature running along north-south direction (as is referred in p. 3.1). The other north-south drainage channel constitutes the upper resources of the Mooi River. This valley is broader, deeper carved, providing a perennial low flow which is significantly increased by the discharge of the Bovenste Oog of Mooi River.

Rainfall and Evaporation Moorivier Dolomitic Compartment



Note: Year 60 - 10/59-9/60

Fig. 2.2.

The Klerkskraal Dam which was built in 1969 has a capacity of $8,68.10^6 \text{m}^3$ and is fed by the Oog of Mooi River and runoff generated from the catchment. Errors in the dam records do not allow calculations of the spillage which could have been related to the average flow of the spring.

3.4 Land use

The main use of the land of this area is two fold; livestock and arable farming. The main crops are maize, sunflower and beans. At present only, small-scale irrigation is practised in the south-west area of Mooi River subcompartment north of Morgenzon farm and almost on the boundary of the dolomite and Pretoria Group rocks.

Note:

Although several farmers have indicated an interest in irrigation from groundwater, it appears that the main obstacle is the cost of drilling to the deep water levels.

4. GEOLOGY

4.1 Regional geology (see map 1.3)

The geology of the area comprises the dolomitic formations of the Malmani Subgroup of the Chuniespoort Group which is part of the Transvaal Sequence. The lithostratigraphy of the area is tabulated below:

GEOLOGICAL CLASSIFICATION COLUMN OF THE INVESTIGATED
AREA

SEQUENCE	GROUP	SUBGROUP	FORMATION	LITHOLOGY	
R A N D I A N	PRETORIA GROUP		ROOIHOGTE	QUARTZITES, SHALES	
	T R A N S V A A L	CHUNIESPOORT GROUP		ECCLES	CHERT-RICH DOLOMITE
				LYTTELTON	CHERT-POOR DOLOMITE
			MALMANI SUBGROUP	MONTE CHRISTO	CHERT-RICH DOLOMITE
				OAKTREE	CHERT-POOR DOLOMITE
				BLACK REEF	QUARTZITES
2 620 m.years					
V A A L I A N				LAVAS	

As was indicated in a report on a prospecting borehole drilled by Anglo-American (borehole number KRT-1, after Polivka 1988) the thickness of the dolomite in the study area appears to be of the order of 1200 m.

4.2 Lithostratigraphy of Malmani Dolomite

The characteristic sequence of the Malmani dolomite which is discussed by (Foster (1988) and Bredenkamp et al. (1986) is again reviewed. The main difference in the dolomite being the chert content and presence of algal stromatolites.

The four formations shown diagrammatically in Figure on the page 5 are the following:

OAKTREE FORMATION (approximate thickness - 200 m)

This formation is characteristically chert-poor with an elephant skin appearance at the surface and weathers to a dark brown dolomite. Occasional thin bands of chert can be seen and large elongated stromatolitic dome features are typical.

MONTE CHRISTO FORMATION (approximate thickness - 700 m)

This formation contains an abundance of chert. The lower part of the formation consists of creamy to white dolomite and many beds are colitic. Above this zone colour banded dolomite is commonly found. The remainder of the dolomite is light grey, becoming darker towards the top. Thin mudstone and shale units can occur within this formation. Several chert-free zones may also be present. A wide variety of stromatolitic forms occur throughout.

LYTTELTON FORMATION (approximate thickness - 150 m)

The Lyttelton Formation largely comprises of dark grey solid dolomite. The paucity of chert is marked. Most commonly the dolomite exhibits a flat lamination.

ECCLES FORMATION (approximate thickness - 380 m)

This is the upper of the four formations of the Malmani Subgroup and is also chert-rich. The dolomite is light to medium grey. But few exposures occur mostly towards the north of the compartment.

The boundaries between the dolomite successions are gradational and are covered by overburden, sediments and chert rubble. Reliable delineation of the boundaries between the formations was therefore only approximate.

4.1.2 Intrusives

The only intrusives commonly present within the area studied are vertical igneous dykes. Only the Holfonfein dyke is depicted on 1:250 000 geological map. The presence of the other dykes was inferred from aeromagnetic surveys supplemented by limited ground-magnetic surveys (Erasmus 1967). Most of the dykes (Holfontein, Mooi River and Almoró) show a preferential N-S strike

direction and only one dyke runs in a East-West direction and was called Wolwekrans dyke in the study of the Tarlton area (Bredenkamp and al 1986).

It is worth noticing that two major offsets of this dyke occurs. It can clearly be seen on Morgenzon and Klipgat Farms. It is suspected that the offsets may indicate some N-S running fault or a dyke intrusion but this could not be confirmed. (See map 1.3.) Those off-sets, particularly on Klipgat Farm, shows some effect clear effect on groundwater levels (see map 1.4). It appears likely that there may be some interaction between surface and groundwaters (groundwater levels are very shallow there). The whole upper resources area of Mooi River occupies large marshy valley coinciding with some kind of the feature that could be traced through and northwards of this offset.

The Holfontein dyke is reported to show negative magnetic anomaly (Bredenkamp et al 1986) and is labelled as a syenitic dyke.

The western dykes (Mooi River and Almore) were found to be diabase dykes (Erasmus 1967) as they show positive magnetic anomaly (Erasmus 1967 et al) which also was confirmed by the author of this report.

Due probably to deep weathering and a thick superficial cover, no fresh dyke material is exposed on the surface within the study area.

Numerous quartz veins exist in the area and their predominant orientation lies between S-N and SSW-NWW and they are considered to play a role in the flow of groundwater.

Of interest is that there are not known sill intrusions within the dolomites of the study area, in contrast to the other dolomite areas where sills commonly occur, for example the East Rand area - Leskiewicz (1984) and Klip River area - Kafri (1986).

4.1.3 Tertiary and superficial deposits

Extensive occurrence of chert and chert breccias outcrop all over the compartment. In most cases it is in-situ deposits that are associated with chert-rich Eccles or Monte Christo formation or Rooihooigte chert breccias. The Lyttelton and Oaktree formation that are chert-poor, has weathered to a red residual soil. Extensive areas of surface wad were observed in the field especially along the Boons-Derby road on the Klerkskraal farm.

Scattered patches of alluvial deposits of manganese and even alluvial diamonds are commercially mined in places. Alluvial gold is also mined since 1987, on the farm Drylands.

4.2 Karst

The study area represents a typical combination of two of the four karst types common to South Africa (Martini and Kavallieris 1976).

These are -

- (i) the Plateau type which is probably more extensively present;
- (ii) the Escarpment type characteristic in the vicinity of the Mooi River valley.

A considerable thickness of soils and overburden material makes it difficult to classify and map the karst features. The road constructions on the farms Klerkskraal and Bovenste Oog van Mooi River, reveal sharp dolomitic pinnacles, irregular dissolution openings and sandwiched chert. This indicates that the underlying dolomite may pose a risk of sinkhole formation and land subsidences. Supporting evidence that such a possibility exists was found by the author on Leeupan, Phatiki and Meadows farms where during this investigation five new sinkholes had occurred and 4 old (tertiary) sinkholes had been reactivated.

All sinkholes that were previously formed and new ones (1988 - 1989) are documented on the geological map. (See map 1.3.)

5. HYDROCENSUS

Since the Mooi River compartment had not been investigated previously, a borehole census was conducted to provide geological and hydrological data as well as information on the usage and quality of the water.

The hydrocensus covered 44 cadastral farms subdivided into 160 separate owner units. Although a total of 330 boreholes were surveyed, reasonable documentation of information for only 126 could be found.

A large number of boreholes (approximately 600) were drilled but had to be abandoned due to their low yields or because it was not possible to penetrate the aquifer to the depth of the water level.

The water table of the boreholes that were surveyed are shown on the groundwater level contour map (Map 1.4) and statistics are listed in Table 3.1 and 3.2.

The information of the borehole survey was computerised and stored on the G-base data base and will later on be transferred to the main groundwater data bank on the Burroughs computer.

The survey has revealed some shortcomings namely:

- (i) Boreholes did not always penetrated the full aquifer thickness.

- (ii) Yields of boreholes mostly reflect only a portion of the real capacities due to the problems referred to in (i) and to inadequate testing.
- (iii) Some boreholes for water level monitoring could not be measured since access to the farms were not possible (gates locked) and in several cases boreholes were blocked.

The hydrocensus revealed that groundwater abstraction is virtually only utilized for agricultural purposes and household usage so that the total abstraction is rather small. A summary of groundwater abstraction from farms are presented in table 3.3 and a conservative estimate of the agricultural consumption is of the order of 2,5 to $3,0 \cdot 10^6 \text{ m}^3$ (as for 1989).

TABLE 3.1: BOREHOLE SURVEYED STATISTICS

FARM NAME	CADASTRAL FARM NO.	NUMBER OF BOREHOLES REPORTED AND VISITED	NUMBER OF BOREHOLES IN WATER LEVELS MEASURED
Platklip	40 IQ	12	3
Kaalfontein	44 IQ	7	2
Houtkop	43 IQ	5	2
Vooruitsig	48 IQ	5	3
Arena	54 IQ	2	2
Holfontein	49 IQ	9	5
Wildfontein	52 IQ	10	3
Leeupan	53 IQ	9	7
Moadowns	39 IQ	9	7
Ireton	32 IQ	9	6
Pahtiki	55 IQ	14	6
Bospan	56 IQ	10	9
Grens	31 IQ	3	2
Goedgedacht	27 IQ	6	5
Buchansvale	61 IQ	2	2
Preston pans	59 IQ	1	1
Leeuwpan	58 IQ	3	1
Drylands	64 IQ	3	2
Digby Plain	63 IQ	3	1
Somerville	62 IQ	3	1
Elandsfontein	21 IQ	3	1
Kleingenoeg	17 IQ	1	1
Klipgat	18 IQ	10	5
Bovenste Oog van Mooi River	68 IQ	9	6
Klerkskraal	65 IQ	8	3
Wolvenfontein	74 IQ	3	2
Eileen's home	67 IQ	2	0
Nooitgedacht	69 IQ	3	3
Morgenzon	9 IQ	10	5
Weltevreden	16 IQ	4	0
Rooibees	8 IQ	4	1
Hartebeesfontein	14 IQ	3	2
Amalia	6 IQ	3	2
Avondzon	7 IQ	3	1
Almoro	173 IP	4	1
Melville	175 IP	3	0
Illmasdale	70 IQ	2	2
Wildebeeslaagte	72 IQ	4	3
Ryedale	75 IQ	2	1
Otlands	79 IQ	3	1
Morgenzon	9 IQ	1	1
Krugersdal	5 IQ	3	1
Leeuwfontein	3 IQ	2	1
Wolvengat	2 IQ	3	1
TOTAL		220	115

TABLE 3.3: POTENTIAL PRIVATE BOREHOLE ABSTRACTION

FARM NAME	CADASTRAL FARM NO.	NUMBER OF BOREHOLES PUMPED	POTENTIAL ANNUAL ABSTRACTION (m ³)
Platklip	40 IQ	3	78 850
Kaalfontein	44 IQ	3	62 800
Houtkop	43 IQ	3	157 700
Vooruitsig	48 IQ	2	78 850
Arena	54 IQ	2	47 100
Holfontein	49 IQ	6	235 500
Wildfontein	52 IQ	3	47 000
Leeupan	53 IQ	5	125 600
Moadowns	39 IQ	3	78 800
Ireton	32 IQ	4	94 200
Pahtiki	55 IQ	5	188 400
Bospan	56 IQ	6	188 400
Grens	31 IQ	2	31 400
Goedgedacht	27 IQ	4	125 600
Buchansvale	61 IQ	2	62 800
Preston pans	59 IQ	1	15 700
Leeuwan	58 IQ	2	15 700
Drylands	64 IQ	3	110 000
Digby Plain	63 IQ	2	31 400
Somerville	62 IQ	1	15 700
Elandsfontein	21 IQ	2	31 400
Kleingenoeg	17 IQ	2	15 700
Klipgat	18 IQ	5	78 800
Bovenste Oog van Mooi River	68 IQ	5	94 200
Klerkskraal	65 IQ	5	31 400
Wolvenfontein	74 IQ	2	31 400
Eileen's home	67 IQ	1	15 700
Nooitgedacht	69 IQ	1	15 700
Morgenzon	9 IQ	5	78 800
Weltevreden	16 IQ	1	15 700
Rooibeas	8 IQ	1	15 700
Hartebeesfontein	14 IQ	1	15 700
Amalia	6 IQ	1	15 700
Avondzon	7 IQ	1	15 700
Almoro	173 IP	1	15 700
Melville	175 IP	1	15 700
Illmasdale	70 IQ	1	15 700
Wildebeeslaagte	72 IQ	2	47 100
Ryedale	75 IQ	1	15 700
Otlands	79 IQ	2	47 100
Morgenzon	9 IQ	1	15 700
Krugersdal	5 IQ	1	15 700
Leeuwfontein	3 IQ	1	15 700
Wolvengat	2 IQ	1	15 700
TOTAL		105	2.435.850

NOTE:

Estimates of annual abstraction are based on data obtained during hydrocensus interview with each land owner and, or worked out of the best estimates of agricultural stock and household consumption needs.

6. GEOHYDROLOGY

6.1 Geohydrological environment

6.1.1 Aquifer

The different dolomitic formations exhibit different aquifer properties. The so-called chert-poor Oaktree and Lyttelton formations constitute the worst aquifers. The lower sequence Oaktree rests usually conformably on Black Reef quartzites and can reach a thickness of 250 - 280 m. This formation shows typically low porosity and transmissivity values and rarely yields strong boreholes. The second chert-poor formation is the Lyttelton Formation which is also poorly leached and sustains only low yielding boreholes. Numerous boreholes are completely dry e.g. on the farm Wildfontein 52 IQ approximately 60 boreholes were drilled of which only four were successful (yielding above 1 l/s).

The other two formations i.e. the chert-rich Monte Christo and Eccles which are better leached and form large solution channels or cavernous dolomite, constitute the major aquifer and frequently yields a high ratio of strong boreholes. Information on these two formations is insufficient since no deep drilling was carried out as a result technical difficulties to drill to those levels. Some boreholes show a surprisingly deep water level (more than 130 m below surface) particularly on the farm Ireton, Pahtiki, Leeupan. The highest yields according to the local farmers were in the range of 15 - 20 l/s. Statistics about the borehole yields in the different formations are indicated Table 3.2.

TABLE 3.2: Borehole yield statistics

(In different dolomite formations)

Formation	Total number of reported boreholes	Number of successful	Average yield (l/s)	Number of dry boreholes	Ratio of successes (per cent)
Eccles	120	30	10	90	25
Lyttelton	60	19	4	41	32
Monte Christo	210	53	12	159	26
Oaktree	96	26	3	70	28
TOTALS	486	128	7	358	26

6.1.2 Compartments

There is no conclusive evidence from water levels that the bounding dykes give rise to completely separate compartments but in places water level anomalies indicate that the dykes act as boundaries e.g.

- (i) North; the area between the Wolvekrans dyke and the Pretoria Group formations is signified by a steep drop in water levels (up to 100 m) occurring over a distance of 1 to 2 km coinciding with the transition between the Pretoria Group and the Eccles Formation that was faulted in E-W direction and intruded by Wolvekrans dyke.
- (ii) Southern boundary: the outcropping quartzites of the Black Reef also act as a boundary due to its much lower transmissivity.

- (iii) Eastern boundary: Holfontein N-S dyke appears to be practically impermeable and is regarded to be a definite boundary.
- (iv) Western boundary: Almore N-S dyke system is also regarded as a pronounced boundary.
- (v) Inter-compartments boundary: Mooi River dyke that subdivides the study area into two subcompartments which are called the West and East Mooi River compartment (see map 1.1)

6.1.3 Springs

Spring No. 1 (Holfontein spring): This spring had stopped flowing during 1985. Data on the flow of this spring is not available. It is believed that surplus groundwater available in Tarlton compartment was since neutralised by:

- a continuing subaverage rainfall recharge to the compartment since 1979 - 1980.
- possible dewatering being caused by the increased irrigation that developed in the Tarlton agricultural community.

Spring No. 2 Bovenste Oog

This large dolomitic spring still discharge water but at a much lower rate than during the period 1974 - 1978. The present (1989) flow is possibly about half the high flow. The high level mark of the water surface outlined on the rock-face at the main issuing point of the spring outflow, suggests an approximate drop of more than 0,60 m in the water level of the main discharging point.

Apart from the main discharge point flow is enhanced further down by seepage issuing from the vlei area. No monitoring of the spring flow by the Directorate of Hydrology had been attempted so far.

6.1.4 Groundwater levels

The main task in the present survey was to compile a groundwater level map (see map 1.4) to picture the subsurface drainage. This indicates that groundwater inflow occurs to the compartment from the south-west and to lesser extent along the northern bounding dyke because of the steep gradients. The anomalous, large groundwater depression showing up in the area of Irenton, Leeupan, Pahtiki farms cannot be explained satisfactorily at this stage. The clear displacement of the isolines across the two major N-S dykes. (Almoro and Holfontein dykes) and the E-W lineament (Wolvekrans dyke) suggests that they act as boundaries or partial boundaries (ref. 6.1.2) .

A comparison of the groundwater levels in the Mooi River subunit (1460 and 1470 m isolines) between the survey of 1967 and 1989 based on results by Erasmus (1967) and the present groundwater table indicates that the present groundwater level is about 10 m higher (see maps 1.4 and 1.5). If this phenomenon is not due to higher recharge over the later period it could be due to the effect of the Klerkskraal Dam (ref. p.3.3) on the natural groundwater level.

6.2 Groundwater chemistry

Electrical conductivity measurements were carried out in the field from which the total dissolved solids (TDS) were determined.

Only 15 selected groundwater samples were submitted for full chemical analyses. These results are presented in the table 3.3. Typical concentrations of total dissolved substances ranged between 200 to 300 mg/l for the main compartment area (Holfontein - Mooi River). Up to 480 mg/l was measured on the farm Bovenste Oog van Mooi River north of the eye, on western side of the Mooi River dyke.

The low TDS values 30 - 60 mg/l characterize water on the northern and Black Reef water from southern boundary zones. It is not possible to determine if an influx of fresh water (non dolomitic) to the dolomite is taking place.

6.3 Groundwater flow

(refer to groundwater contour map Fig. 1.4)

Although it is difficult to compile a groundwater balance the following points are relevant:

- * The deep water levels rule out any significant evapotranspiration losses from the groundwater reservoir over most of the study area;
- * evapotranspiration losses and also outflow occurs where the upper Eye of Mooi River discharges. High evapotranspiration does occur from the marshy area just above the Klerkskraal Dam;
- * the losses by abstraction from private boreholes are relatively small since almost no irrigation exist in the study area;
- * the groundwater inflow from the adjoining formations of the Pretoria Group or Black Reef is probably also insignificant judged by the steep groundwater gradients and the distinct difference in TDS values;
- . there is a possibility that external dewatering of the Holfontein - Mooi River compartment occurs as this would explain the cone of depression occurring within the compartment in the area of Irenton 32 IQ, Leeupan 53IQ farms.

7. CONCLUSIVE SUMMARY

The hydrocensus and the preliminary analyses of the survey has revealed the following:

- (i) The existence of the Mooi River dyke (not shown on the latest 1:250 000 geological map);
- (ii) That the Mooi River dyke act as a boundary causing the Upper Eye of Mooi River to emanate on its side.
- (iii) The existence of a groundwater divide to the east of the Mooi River dyke.
- (iv) The existence of a large groundwater depression with a low of 1450 metres a.m.s.l. groundwater levels of 136 m below surface. The depression can only be explained by some prominent deep conduit draining groundwater. This could even be due to the adjacent lying Ventersdorp Oberholzer and Bank compartments which are at present being dewatered. If so this could also explain the apparent steady state conditions in the Venterspost/Bank compartments that were observed by Foster (1989) and the high recharge value that he deduced.
- (v) As was reported by Bredenkamp at al (1986) the flow of Holfontein spring has ceased. This is ascribed to irrigation from boreholes which has expanded over the last 5 years.

- (vi) The upper eye of Mooi River is still flowing strongly but reports of the local farmers, which is substantiated by the lower water level in the spring compared to the high flow marks suggest that flow of the spring has diminished substantially - it is reckoned that the average flow could be about 300 l/s and the low flow (present) 100 l/s.
- (vii) No large scale consumption of the groundwater was identified within the study area.

GENERAL DISCUSSION

A. West Mooi River subcompartment is characterised by:

- very shallow groundwater gradients (<0,001)
- shallow water table below surface (<5,0 m over large area)
- significant number of shallow boreholes yielding up to 20 l/s (reported by owners)
- relatively the worst groundwater quality occurs in the East Mooi River subcompartment (TDS 350 mg/l)

B. East Mooi River subcompartment is characterised by:

- steep and variable groundwater gradients
- deep to very deep water table (> 70,0 m and up to 136,0 m below ground level)
- the majority of boreholes are deep (> 150,0 m) and of low yield (3 - 5 l/s)
- good to excellent quality of water (TDS < 240 mg/l)

C. Recharge

No attempt was made to evaluate the recharge of the investigated compartments. It is believed that because of the great similarity between this area and that of the adjacent compartments of the Tarlton area, the recharge must be similar to estimates by Bredenkamp (1986) indicating it to vary between 15 per cent and 21 per cent of the average rainfall. Assuming groundwater recharge to be 20% of the rainfall yield that $121 \cdot 10^6 \text{ m}^3$ would be annually available for utilisation from the whole area of Mooi River compartments.

If the recharge is only 10% of the rainfall which is the latest value for the Bo-Molopo area (Bredenkamp et al 1989), the recharge would be $60 \cdot 10^6 \text{ m}^3/\text{a}$. In addition to the direct recharge effected by rainfall on the dolomite some external recharge occurs from -

- (i) surface runoff in the Mooi River valley; and
- (ii) the adjacent formations as indicated by the groundwater contour map.

D. Groundwater quality

TDS values ranging from 30 - 500 mg/l suggest that the overall quality of the groundwater is very good.

No potential pollutants were located within the study area.

E. Ground stability and geological engineering problems

An alarming number of new sinkholes have occurred on the farm Leeupan 53 and Pahtiki 55. During the period January till April 1989 as many as five new sinkholes have appeared in spite of the groundwater levels being deeper than 100 m which was regarded a safeguard against sinkhole formation. Two sinkholes were reported between October to December 1988 and some of the older sinkholes were also reactivated.

It is interesting to note that almost all the recent sinkhole activity was concentrated within or in the immediate vicinity of depressional cone where water levels are deep. This fact is in direct contrast to the general assumption that sinkholes are not likely to occur where the water levels are deep.

8. RECOMMENDATIONS

1. It is strongly recommended that the present hydrological study be extended -
 - to study the area where the large cone of depression occurs and drill two boreholes to investigate it further;
 - to establish groundwater level trends by mean of a network of monitoring points;
 - to study the hydrogeological picture of adjacent compartments e.g. Oberholzer and Bank in order to establish possible interreaction between the two systems;
 - to futher investigate the groundwater divide that appears to exist in the proximity of the Mooi River dyke;
 - to later on carry out a further borehole census on the farms that were inaccessible during the present survey.
 - consider the possibility of drilling two to three exploration boreholes in this area;
 - to attempt a quantitative analysis of the inflow of the Klerkskraal Dam and relate that to the flow of the upper Eye of Mooi River;

- groundwater age determination should be contemplated on Oog van Mooi River water and two selected boreholes; one that represents Mooi River subcompartment and other one representing "cone of depression" area.

- to carry out a computer simulation study at some stage.

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