dorsal surface of the skulls and the crucifix-like arrangement of the bones on the ventral side clearly indicate that the specimens belong to the siluroid genus, *Arius*. One of the specimens (G.S.I. No. K56/155) is very similar to *Arius kutchensis* known from the Laki beds of Kutch (Rao, 1956). However the other two skulls (G.S.I. Regd. Nos. K56/157 and K56/159) are different and belong to new species (Fig. 4).

The detailed taxonomic description will be published later.

Archaeoceti are the earliest whales which appear first in Eocene presumably derived from an early creodont stock. Fossils are known from the Eocene of North America and Europe but most of the oldest and primitive types are from African region. In India the only Eocene cetacean known is *Protocetus sloani* from the Middle Eocene of Kutch (Sahni & Mishra, 1972). The present report of new Eocene cetaceans and associated siluroid fishes from Kutch indicates continuous sea connection during early Tertiary from Africa facilitating free intermigration.

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HYDROGEOLOGY OF THE JABALPUR SANDSTONE OF JABALPUR DISTRICT, MADHYA PRADESH

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Introduction: Jabalpur formation of Upper Gondwana System occurs in Jabalpur district of Madhya Pradesh between the north latitudes 23°06′ and 23°16′ and the east longitudes 79°54′ and 80°08′. The area is within 20 km of Jabalpur city. The railway line between Howrah and Bombay via Allahabad and the all weather road from Nagpur to Varanasi pass through the area. In the present paper the authors have presented a picture of the hydrogeology of the Jabalpur Sandstone.

Geology: The geological succession in the Jabalpur area of Jabalpur district of Madhya Pradesh is as follows (mainly after Matley, 1922):

TABLE I

GEOLOGICAL SUCCESSION AROUND JABALPUR

Formation	Maximum thickness (in m)	Lithology
1	2	3
Deccan Trap	40	Basalts
Lameta	48	Upper sands, Calcareous sandstone, Mottled nodular bed, Main limestone, and Greensand
Jabalpur (Upper Gondwana)	105	White clays, conglomerates, sandstones and shales with coal
---------- Unconformity ----------		
Pre-Cambrian		Granite, Tremolite-actinolite schists and marbles

Groundwater: Groundwater occurs under water table condition in the granites of the area. The wells are within a depth range of 11 m with an areal extent of 12 sq. m. In winter water levels range from 3 to 8 m b.g.l. with a further lowering down to 5 to 10 m in summer. The wells are yielding up to 80 klpd, the higher yields being from areas of topographic lows.

In Jabalpur formation, groundwater occurs under both water table and confined conditions. The open wells are within 17 m in depth and upto 40 sq. m in cross-sectional area. The water levels in them range from 5 to 12 m b.g.l. in winter lowering down to 8 to 13 m b.g.l. in summer. The wells are yielding up to 10 klph for a drawdown of 2 metres.

The western part of the basin has been developed by tubewells with the following hydraulic characteristics:

TABLE II

HYDRAULIC CHARACTERISTICS OF THE JABALPUR FORMATION

Zones	Number of tubewells	Depth range (in m b.g.l.)	Aquifers (in m)	Static water levels (in m b.g.l.)	Yield (in klph)	Drawdown (in m)
1	2	3	4	5	6	7
Northern	3	45–47	11–23 29–40	8 to 22	10 to 20	2 to 9
Central	30	45–103	18–38 49–52 68–82 87–90 93–98	5 to 35	20 to 45	2 to 6
Southern	3	60–70	36–41 43–47 51–56 57–83 86–89	5 to 7	45 to 155	5 to 6

Aquifer tests conducted on select wells have provided the following aquifer coefficients.

TABLE III

AQUIFER COEFFICIENTS OF THE WELLS IN THE JABALPUR FORMATION

Zones	Transmissibility (in IGPD/ft)	Permeability (in IGPD/sq. ft.)
1	2	3
Northern	1,400	15
Central	3,400	20
Southern	15,400	110

The low values of the aquifer parameters in the Northern and Central zones may be due to choking and screen losses of the tubewells. However, the data indicates that the transmissibility and permeability are higher in the Central zone than in the Northern zone, the highest being from the Southern zone.

In the Lameta formation also groundwater occurs under both water table and confined conditions. Open wells are within depths of 4 m with cross-sectional areas of about 3 sq. m. In them the static water levels range from 0.5 to a metre b.g.l. in winter, lowering down to about 1 to 2 m in summer. The wells are yielding up to 12 klpd. Though there are no tubewells exclusively in the Lameta formation, there are perennial springs yielding up to 13 klpd in the greensand of the Lametas indicating thereby local confined conditions.

Discharge and Replenishment: It has been estimated that the annual withdrawal from tubewells in the Jabalpur Sandstone is of the order of 6 million kilolitres; and the main source of recharge is local precipitation. However, intraformational recharge from the Lameta formation cannot be ruled out, and recharge from the local Pariat tank has also been noticed.

Chemical Quality: The results of chemical analyses of six water samples from the tubewells are summarised in Table IV.

Concentration of sodium (5 to 19 ppm) in the groundwater is well within permissible limits for irrigation. Further, the magnesium content ranges from 20 to 24 ppm, calcium from 43 to 64 ppm and boron less than 0.1 ppm. Hence use of this water is not likely to cause any sodium or alkali hazard. On the contrary, it has an added advantage of making the soil flocculent and more permeable.

The water is only weakly alkaline to moderately hard, which may mean softening for boiler feed, paper, breweries, rubber, tanning and steel industries.

Scope for Groundwater Development: There lies scope for development of groundwater in the Jabalpur Sandstone for both irrigation and water supply to the townships by constructing moderate duty tubewells, maintaining a distance of about 0.3 km between consecutive wells to avoid interference. The tubewells in the area may range in depth from 60 to 100 m with a diameter of 60 cm with effective screens and gravel pack.

TABLE IV

CHEMICAL ANALYSES OF TUBEWELL WATERS FROM THE JABALPUR FORMATION

Constituents 1	From depth range of 60 to 103 m (in ppm) 2
Sodium	5–19
Potassium	1–2
Calcium	43–64
Magnesium	20–24
Carbonates	Trace–23
Bicarbonates	108–501
Sulphates	Traces
Chlorides	5–30
Silicon	20–30
Fluorides	< 0.1
Boron	< 0.1
Total dissolved solids	340–430
Hardness as $CaCO_3$	100–540
Specific conductance in micro/mhos at 25°C	129–745
pH	8–8.6

Conclusions: 1. The Jabalpur Sandstone forms a linear basin of 70 sq. km with an established thickness of 105 m over the basement of pre-Cambrian granites, schists and marbles. Lametas overlie the Jabalpurs, occupying an area of about 10 sq. km with an established thickness of about 48 m.

2. It is thus an important hydrogeological unit with a favourable roof of the Lametas and a fairly compact basement.

3. Groundwater occur under both water table and confined conditions; and it is possible to recognise three zones in depth with range in yield from 10 to 20 klph, 20 to 45 klph and 45 to 155 klph from the tubewells.

4. The chemical quality of water is good for both irrigation and domestic use, but softening may be necessary for certain specific industries.

5. Groundwater development is possible in the area by a network of tubewells with a spacing pattern of 0.3 km between consecutive wells. These tubewells may be 60 to 100 m or more in depth and 60 cm in diameter with effective screens and gravel pack for optimum yield and durable service.

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