



Arc GIS based Cretaceous Geological Information System (CGIS) of Ariyalur outcrops - Cauvery basin, India

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Abstract: The rock strata of Cretaceous sedimentary system represented by Aptian to Maastrichtian age occurs as isolated patches outcropping in the western margin of the Cauvery Basin bordering the Archaean granite and gneiss basement. The Cretaceous system is well known as “Cretaceous of Trichinopoly” containing diverse fauna and flora including dinosaur remains, commercially exploitable limestone, lignite, clays and hydrocarbons. As a result, this fossiliferous sedimentary system has attracted the attention of many geoscientists from all over the globe to conduct research on various geoscientific disciplines. However, the published geological information is not archived at a single source for perusal and reference. This study attempts to collate available Cretaceous geological information of the Ariyalur outcrops - Cauvery Basin at one source in digital form to the user end in an Arc GIS platform, as it is an effective tool for mapping and storing the data. The published information related to the Cretaceous system is digitized and integrated in the Arc GIS environment. Subsequently query cells format was developed to archive the required information on preliminary 24 geological parameters can be perused and obtained by using query cells. This is the first ever attempt to document Cretaceous Geological Information System (CGIS) in a GIS platform for the Ariyalur outcrops - Cauvery Basin. CGIS is a user friendly to address the Cretaceous geology for multiple applications in scientific investigations, petroleum and mining industries.

Keywords: Arc GIS, Cretaceous, Information system, Ariyalur, Cauvery basin

1. Introduction

The Cauvery Basin extends along the south east coast of India from the Pondicherry in the north to the Tuticorin in the south. The basin covers an area of 1.5 lakh km² comprising 25,000 km² on land, 30,000 km² in shallow offshore areas and about 95,000 km² of deep-water offshore areas (Nallapa Reddy et al., 2013). The Cretaceous system of the Cauvery Basin ranging in age from Aptian to Maastrichtian (~120-65 million year) is exposed in the Ariyalur and Perambalur districts of TamilNadu (Tewari et al., 1996; Sundaram et al., 2001; Nagendra et al., 2011). The analogue of the exposed Cretaceous system in the subsurface hosts commercial hydrocarbon accumulations. Therefore, the Cauvery Basin has been intensely explored for hydrocarbon resources since 1980s. The Cretaceous exposures in the Ariyalur area have been extensively studied for various geoscientific aspects since Blanford (1862) conducted first survey. Since then over 500 research papers are published on the Cretaceous system of the Cauvery Basin. The basin also contains vast deposits of organic limestone which is unearthed since 1950s to consume in cement manufacturing. Due to mining activity many geological formations are exposed in their full view for observation and analysis.

Therefore, the Cauvery Basin becomes the foremost priority for geoscientists to undertake various advanced studies on the well exposed outcrops in mine/quarry sections. The outcrop data can be subsequently projected and integrated with subsurface sections for cost effective and successful exploration of hydrocarbon, limestone and lignite resources.

As a result, many researchers from all over the globe are carrying out studies on the Cretaceous rock exposures of the Cauvery basin. However, many researchers fail to access the available literature, because of lack of all or most of the important literature in one source. Therefore, an idea has emerged to pool up all the available literature with the authors on Cretaceous system of the Cauvery basin, and to archive in Arc GIS environment so as to facilitate researchers, academicians and user agencies to query and retrieve the requisite geoscientific information.

Geographic Information System (GIS) provides a good framework for solving classical problems in the earth sciences and engineering (Vasquez, 2014) and is an effective tool for storing and mapping of the geoscientific data. GIS has transformed the way for

interactive query, process, analysis, mapping, modeling, visualization and display of spatial data for an increasingly large range of users for a multitude of purposes (Krishna et al., 2010). Nemoto and Kimura (2010) developed a Web-GIS system for sharing and visualising geologic data such as borehole data, geological map and 3-D geologic model. The system they developed supports in handling of geologic data, two and three-dimensional visualisation of geologic model and analysis of borehole data.

In the proposed system, data can be logged, diagrammed and stored so that it can be perused to know the published information on various sub disciplines of geology such as lithostratigraphy, biostratigraphy, tectonics, sedimentology, paleoenvironment and magnetostratigraphy carried out on the Cretaceous rocks of the Cauvery basin. This is the first ever attempt to develop Cretaceous

Geological Information System in a GIS platform for the Ariyalur outcrops - Cauvery Basin.

2. Geological setting

Figure 1 and Table 1 illustrate the lithostratigraphy and lithotypes exposed in Ariyalur area - Cauvery basin (Nagendra et al., 2011).

3. Objectives of the study

The objectives of the study are 1) to generate a geospatial data base for Cretaceous rocks of the Cauvery Basin using published geological records, and 2) to develop Arc GIS software based query system for retrieval of information from available geological records of the Cretaceous period of the Cauvery Basin.

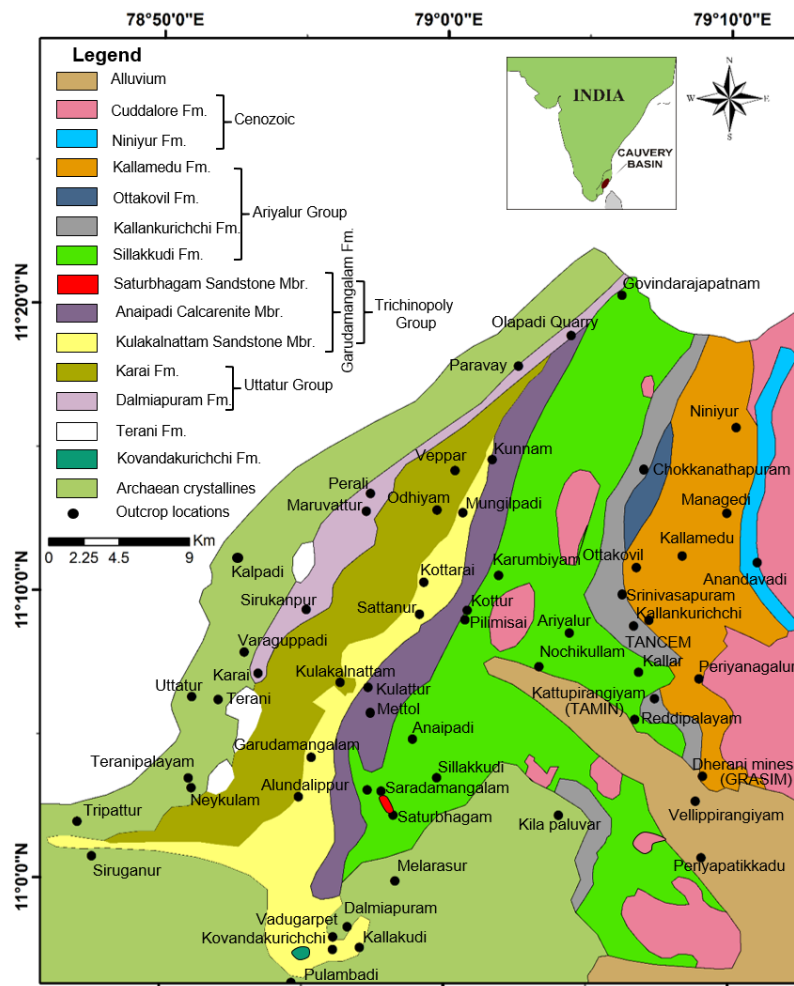


Figure 1: Geological map of Cretaceous sediments, Ariyalur area, Cauvery basin

Table 1: Lithology of the Cretaceous outcrops - Ariyalur area

Stratigraphic Group/ Formation/Member	Lithology	Lithological description
ARIYALUR GROUP Kallankurichi Formation (44m) [†]	Kallamedu Formation. (300m) [†]	Thick sandstone, inter-bedded with sandy claystone, sands are white to grey, friable fine- to medium- grained, moderately to well-sorted, well-preserved, cross bedding structure.
	Ottakovil Formation (60m) [†]	
	Upper arenaceous limestone (UAL)	White grey to pale yellowish, medium- to coarse- grained sandstone with calcite cement.
	<i>Gryphaea</i> limestone (GL)	UAL- Poor in both macro and microfossils with rich terrigenous input.
	Lower arenaceous limestone (LAL)	GL- Reddish fine- to medium-grained, massive, rich in lime content. <i>Gryphaea</i> , <i>Alectryonia</i> and <i>Exogyra</i> are abundant.
	Ferruginous limestone (FL)	LAL- Yellowish, massive, highly compacted, rich in silica content, associated with microfossils.
	Kallar Conglomerate	
Trichinopoly Group Garudamangalam Formation	Sillakkudi Formation (600m) [†]	FL- Fine- to medium-grained, massive biomicrite.
	Saturbhugam Sandstone	
	Anaipadi Calcarenite (264m) [†]	Conglomerates-unconformity surface. White buff color, medium- to coarse-grained sandstone, poorly-sorted, friable to hard, calcareous.
	Kulakkalnattam Sandstone (230m) [†]	Coarse-grained reddish white sandstone with well preserved current bedding structures-fluvial sandstone. Sandstone with wood fragments, gastropods shells and ferruginous concretion.
UTTATUR GROUP Dalmiapuram Fqrmation (236m)	Marl (ML)	Fine- to coarse-grained, calcareous sandstone. Silty sandstone, texturally immature poorly-sorted, enriched in calcite cement. ML- Yellow in colour, compact, friable, massive and highly ferruginised. The fabric resembles that of wackstone.
	Marl bedded limestone (MBL)	MBL- Cyclic deposition of limestone/marl. White to greyish brown in color. Grey to dark grey, poorly fissile, silty, calcareous shale with mica, pyrite, smectite clay.
	Karai Formation (410m) [†]	
	Coral algal limestone (CAL)	CAL- Massively bedded, hard, compact, variegated coral reefoidal limestone with pink to flesh red color giving a mottled appearances, dissolution vugs and cavity.
Terani Formation (60m) [†]	Terani gritty ferruginous sandstone	
	Terani Claystone with sandstone intercalations	Coarse gritty sandstone- quartzwacke to lithic graywacke. Claystone (kaolinite) with intervening medium- to coarse-grained friable, ferruginous sandstone.
Kovandankurichchi Formation (175m) [†]		Boulder conglomerates / fanglomerate.
Gneisses, charnockite and granulites		Gneiss, charnokites, granulites.

4. Methodology

The scope of this study was to develop the information system of Cretaceous geology of Ariyalur outcrops - Cauvery Basin. The archives of a data base on Cretaceous rocks was digitized and moved into a GIS platform for the development of query system.

5. Basic data used

1. Topographical map of the Ariyalur district, Toposheet numbers; 58 M/3, 58 M/4, 58 I/16, 58 I/15, 58 J/13 & 58 N/01).
2. Google Earth Satellite imagery.
3. Satellite imageries of the study area from USGS, BHUVAN.

4. Published geological records of the Cretaceous sedimentary system of the Cauvery Basin basin.

Software used
Arc GIS 10.2

6. Results and discussion

In this study, an attempt has been made to consolidate available geoscientific data of Cretaceous system of the Cauvery Basin in a GIS platform to enable easy access to the user end. The query cell format designed in this study will help to retrieve the geoscientific information archived in CGIS. Therefore, the user can easily scrutinize the data base and envisage nature of research studies are already done and to understand the type of studies need to be initiated on each stratigraphic unit of the Cretaceous system. The CGIS also can help the user to avoid repetition of studies on Cretaceous successions of the Cauvery basin.

GIS commonly provides the basic modules for organization, analysis and processing of geologic data. The data derived from various sources can be integrated and geologic models can be structured in

GIS platform. The structured models can be viewed and obtained by the users for reference if stored in query cell format. In this study, the available data was first digitized and subsequently was moved into Arc GIS 10.2 platform. Then the format for querying the required information was developed for seven stratigraphic formations and twenty six geological parameters. Subsequently the data was directly loaded into the query cell format. The basic geologic information loaded into GIS ranges from location, field photo, age and depositional environment and published literature on each stratigraphic formation. Whenever the user requires particular data set, it can be enquired by selecting identify cursor/ button in the Arc GIS tool bar, then by clicking the identify cursor in the required geological formation ex. Terani and Sillakkudi Formations (figs. 2-5). By this way the geological information for all the formations can be perused and obtained. The complete CGIS for the Cauvery basin is archived in Arc GIS 10.2 and can be made available to the user end.

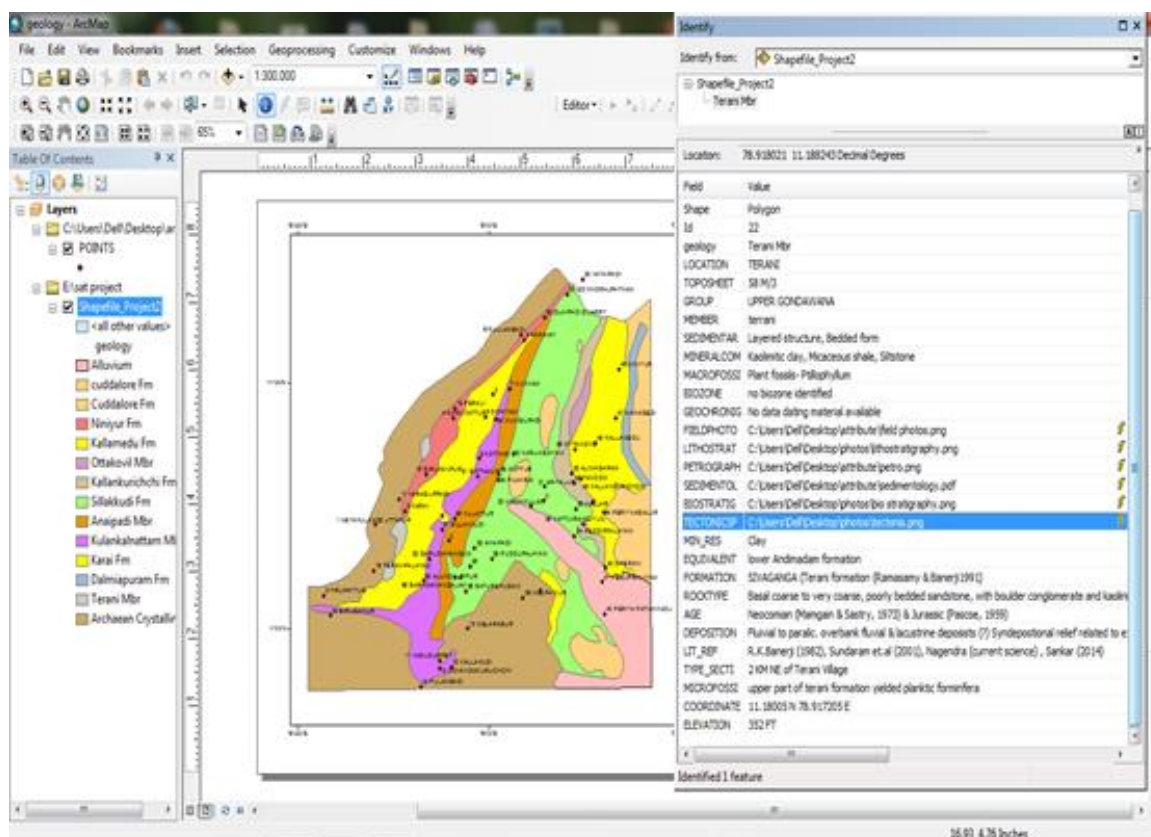


Figure 2: Query cell format for the Terani formation

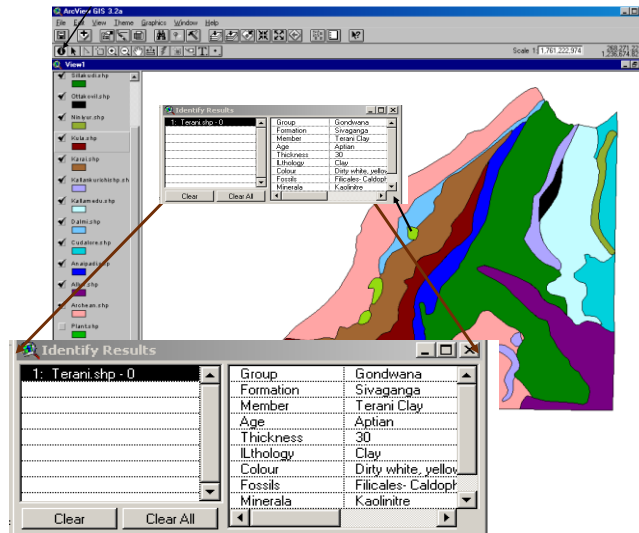


Figure 3: Query cell format for the outcrops

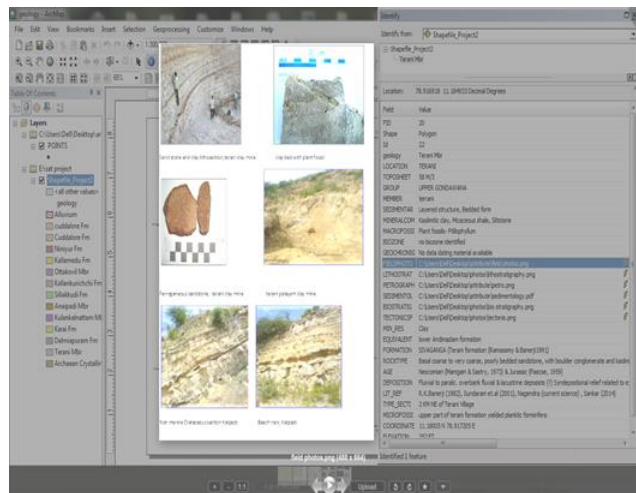


Figure 4: Field photograph of the Terani formation

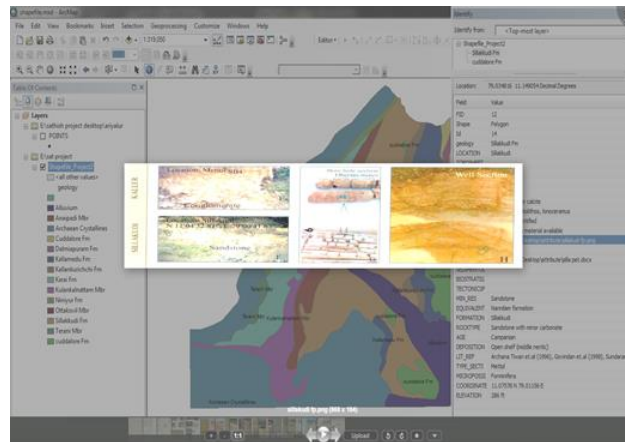


Figure 5: Query cell format and field photograph of the Sillakkudi formation

7. Conclusions

- The GIS technology has many uses in integration of Cretaceous Information System of various sources and their spatial correlation. This technology provides enhanced analysis and understanding of composite data resulting in easier, faster and accurate decision making.
- The available published geological records of the Cretaceous successions of the Cauvery basin were digitized and moved into GIS platform to create Cretaceous Geological Information System (CGIS).
- The Cretaceous information data base loaded into GIS can be perused and obtained using query cell format created in Arc GIS tool.
- Various thematic maps relevant to the Cretaceous Geological Information System are generated and validated with Google image.

The CGIS opens up a user friendly way to access available geological information on Cretaceous of Trichinopoly of the Cauvery basin by the academicians, students, researchers and user agencies to know the status of Acknowledgements

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