PHELPS DODGE EXPLORATION INDIA PVT. LTD.

AP/36/AP/37

REPORT ON EXPLORATION CONDUCTED OVER BADVEL AND RAJAMPET RECONNAISSANCE PERMITS, CUDAPPAH DISTRICT, ANDHRA PRADESH

AMG (Gupta) 12/10 11.10.10

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REPORT ON EXPLORATION CONDUCTED OVER BADVEL AND RAJAMPET RECONNAISSANCE PERMITS, CUDAPPAH DISTRICT, ANDHRA PRADESH

I. INTRODUCTION

1. Background:

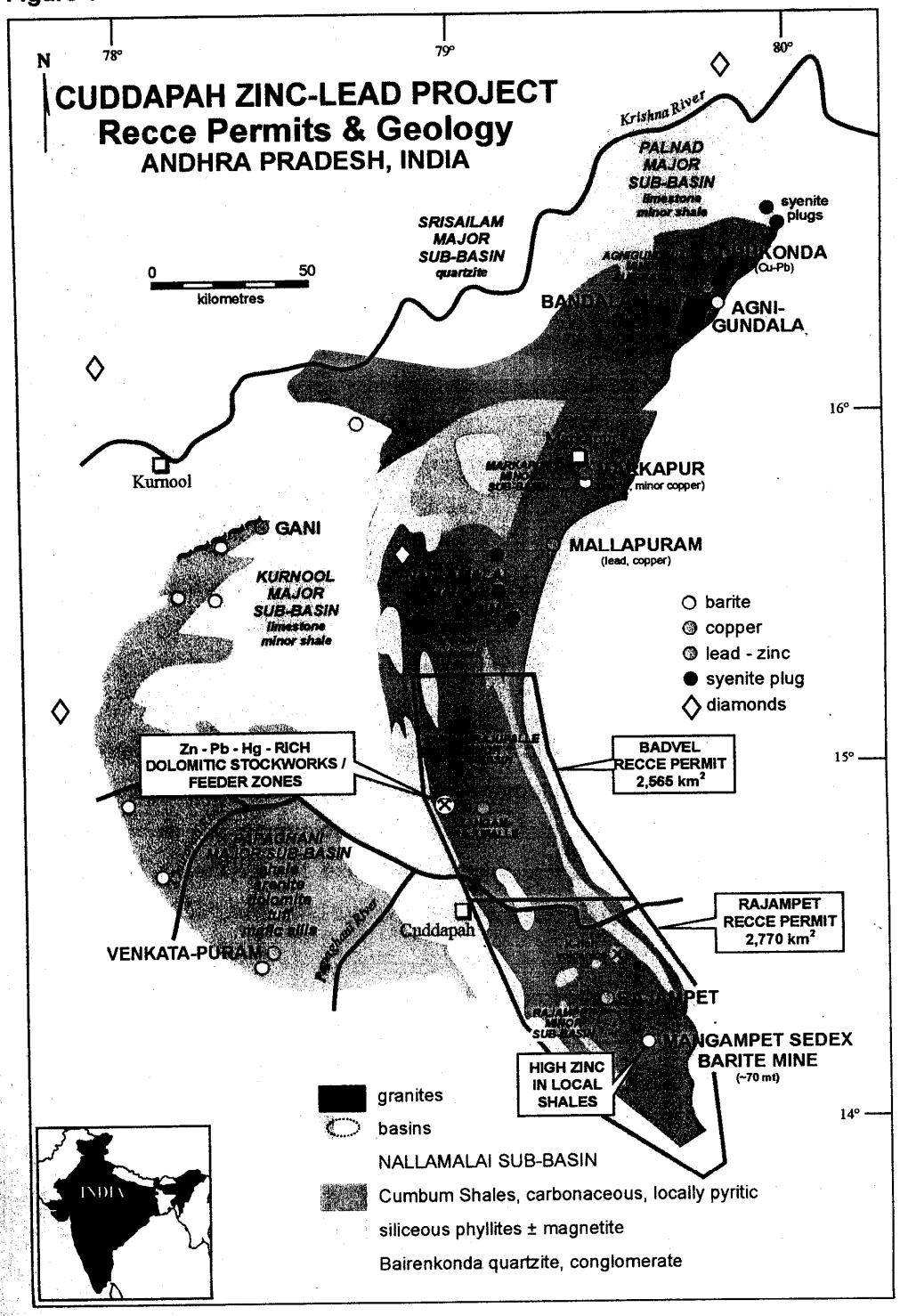
Phelps Dodge Exploration India Private limited (PDI) applied on 27th July, 2000, for Reconnaissance Permits (RP) over contiguous areas covering parts of Naliamalai Group of rocks in the southern part of the Proterozoic Cuddapah basin, (figure. 1), as follows:

Badvel Reconnaissance Permit over 2565 sq. kms in Cuddapah district for the exploration of copper, lead, zinc, silver, barite and associated minerals. This has often been referred to as North Area.

Rajampet Reconnaissance Permit over 2770 sq. kms in Cuddapah district for the same group of minerals, copper, lead, zinc, silver, barite and associated minerals. The world class Mangampeta barite deposits which are held by the Andhra Pradesh State Mining Corporation under mining rights, also fall within this RP area.

The RP's applied for were granted to PDI by the State Government vide Government orders, MS Nos.13 & 14 dated 10th January, 2001, and were personally awarded by the Chief Minister of Andhra Pradesh, Hon. Shri. Chandrababu Naidu to the representatives of Companies invited to the function. At the very outset, Phelps Dodge would like to record its grateful thanks and appreciation for the expeditious manner in which the RP applications were processed, grant orders issued, and for all assistance and guidance that the company received from the State Government during the implementation of our exploration programs.

Figure 1


CUDDAPAH ZINC-LEAD PROJECT
Recce Permits & Geology
ANDHRA PRADESH, INDIA
N
78°
79°
80°
16°
15°
14°
0
50
kilometres
Krishna River
PALNAD MAJOR SUB-BASIN
limestone
minor shale
SRISAILAM MAJOR SUB-BASIN
quartzite
syenite plugs
KONDA
(Cu-Pb)
AGNI-GUNDALA
Kurnool
KAPUR
(minor copper)
GANI
MALLAPURAM
(lead, copper)
KURNOOL MAJOR SUB-BASIN
limestone
minor shale
barite
copper
lead - zinc
syenite plug
diamonds
Zn - Pb - Hg - RICH DOLOMITIC STOCKWORKS / FEEDER ZONES
BADVEL RECCE PERMIT 2,565 km²
RAJAMPET RECCE PERMIT 2,770 km²
VENKATA-PURAM
Cuddapah
PET
NGAMPET SEDEX BARITE MINE
(~70 mt)
HIGH ZINC IN LOCAL SHALES
granites
basins
NALLAMALAI SUB-BASIN
Cumbum Shales, carbonaceous, locally pyritic
siliceous phyllites ± magnetite
Bairenkonda quartzite, conglomerate
INDIA

Phelps Dodge, on 10th January, 2001 filed requests with the Director, Mines and Geology for the inclusion of Diamond of the two RP's granted. Unfortunately, after deliberation over about two years, the requests could not be allowed by the State Government for want of definitive rules for addition of minerals in on-going Reconnaissance Permits .

The two RP's were executed in the office of the Assistant Director, Mines and Geology department at Cuddapah on 22nd March, 2001. Vide its letters dated 25th March, 2003, PDI relinquished 1770 Sq. Kms from its Rajampet RP. and 1565 Sq. Kms from its Badvel RP based on results of exploration and held 1000 Sq. Kms in accordance with Rules, 1960, in each RP during the third year ending on 21st March, 2004. The report highlights the results of the exploration program undertaken in the two contiguous RP areas.

The initial emphasis was geological mapping (Map 2) on a landsat base (Map1) for understanding sedimentary facies in relation to known base-metal mineralisation; identification of sub-basins within the Cumbum formation; stream sediment silts, well water, rock/gossan geochemical investigations and interpretation of airborne EM data procured from the Geological Survey of India (AMSE Wing) for identifying conductive anomalies. This was followed by some detailing within the anomalous zones. The data gathered so far indicates the presence of extensive but extremely patchy, small mineralisation zones in the Badvel (North) RP area, and two potential prospects in the Rajampet (south) area.

1.2. List of Personnel associated with the Exploration Program

Mr. John Biczok- Program Manager
Dr. Thomas Iannelli.
Mr. Tony Goddard, Consulting Geologist
Dr. T.M. Babu
Dr. S. Reginald
Dr. B. Srinivas
Mr. Sandeep Prakash
Mr. M.R. Gautham

Mr. IVVSV Prasad.

Mr. Jonna Chalapathi

Mr. Navin Kumar

1.3. Previous Work

The first reference to the **Geology** (Map 2) of the Cuddapah basin is from the French traveler, Travernier, whose writings of 1639-67 describe diamond workings and trade from parts of the basin, as incorporated in Ball, (1925); as in Nagaraja Rao & others (1987). W. Kings Memoir of the Geological Survey of India, (1872), comprised pioneering geological work on the rocks of the Cuddapah basin by Oldham, King and Foote, who used 1"= 4 mile scale maps of the Survey of India for compilation of geology. The data was synthesized by King (1872) in his classical memoir, in which the rocks of the Cuddapah basin were described and classified into a KADAPAH Formation comprising four sub divisions (or groups), and KARNUL Formation (Table I). Kings stratigraphy remained unchallenged for more than a century, which showed his stupendous efforts and meticulous care with mapping, based on which the regional stratigraphy was compiled.

Coulson (1934) carried out detailed mapping in parts of Vempalle belt for the exploration of asbestos deposits in the lower Cuddapah ultramafics; Narayanswami (1966) presented his five fold stratigraphy of the basin and a tectonic classification followed by Sen and Narsimha Rao's (1967) model which formed the basis for later work. Various igneous bodies were identified in terms of their stratigraphic correlation; and Dutt (1975) apparently recognized the disconformity at the base of the Paniam Quartzite and defined Kurnool as a separate group.

Nagaraja Rao and Ramalingaswami (1976) correlated Nagari with Bairenkonda quartzites; Cumbum with Pullampet, and identified Gandikota quartzite as conformably overlying the Tadpatri Formation. In their stratigraphy they introduced the Chitravati Group comprising Pulivendla quartzite, Tadpatri and Gandikota quartzite. While many appear to favour the five fold stratigraphic classification (Narayanswamy, 1966), it would appear that the classification set out by King (1972) is by and large acceptable even now with modifications as suggested by B.K. Nagaraja Rao & Others (1987). **This recognizes the Papaghani, Chitravati & Nallamalai as distinct groups of the Cuddapah Super Group;** with the overlying Srisailam Quartzite included in a separate Sub-basin underlying the Kurnool Group, unconformably overlying the Cuddapah Super Group. The Table I is a compilation of stratigraphy as proposed by some of the earlier workers.

The Badvel and Rajampet permit areas fall exclusively over parts of the uppermost Cuddapah, the Nallamalai Group of rocks which are the hosts to the world class Barite deposit of Mangampeta in the Rajampet RP, and some significant Lead –Zinc –Copper mineralisation zones established by the Geological Survey of India in the Zangamrajupelle-Varikunta belt within the Badvel RP.

Geophysical data:

The Cuddapah basin was covered by early gravity surveys reported upon by Glennie(1932) with re-interpretations by Quereshy (1968 b). These appear to have been followed by work done by Krishna Brahman and Dutt (1985) National Geophysical Research Institute,. The results in conjunction with Magnetic data over the southwest part of the basin was interpreted to relate to an ellipsoid high, lopolith, over which the Papaghani and Chitravati groups developed in an extentional environment. Recently, detailed gravity surveys appear to have been conducted in the vicinity of Mangampeta barite deposits to aid with exploration programs.

Airborne geophysical surveys were launched in 1967 by the AMSE Wing of the Geological survey of India. The Operation Hard Rock (OHR) comprised flying across (east-west) the Cuddapah basin at intervals of 1-2 kms with a Nuclear Precision Magnetometer, a Mark V Input system for Electromagnetic measurements from Barringer Research Limited, and the scintillation counter of Measurement Engineeering. The data was plotted on 1:31,000 scale uncontrolled photo mosaics. Later, in 1980-82, Airborne magnetics were flown over northeast and southern parts of the Cuddapah basin through a Geological Survey of India program (GSI,1981 b, & Babu Rao,1987 a) by the National Geophysical Research Institute,(NGRI), Hyderabad. Data from OHR and NGRI survey was thereafter, combined to produce a composite Aeromag map of the Cuddapah basin. The data when integrated with lithostratigraphy and structural geology suggests that the complex Cuddapah basin formed in distinctive phases over the Archaen basement in which a rhombic pattern of faulting is deciphered within a system of linear magnetic highs. The pre-existing basement faults were reactivated periodically over Meso and Neo Proterozoic periods to initiate and and develop the Cuddapah basin in distinct phases. The fault systems were also the conduits for the volcanics that were emplaced during the different periods of basin development and sedimentation of the Papaghani, Chitravati and the Nallamalai Groups that comprise the Cuddapah Super Group. The Kurnool (along with Srisailam formations) appear to have been given the status of a younger group that formed essentially within the primary basin, however ,after a major phase of deformation and erosion of the underlying Nallamalai formations. The following paragraphs briefly describe the findings of the earlier workers on the barite deposits, as well as, the known base-metal occurrences within the Nallamalai formations:

Mangampeta barite deposits, (Figure I)

As investigated by earlier workers, (Neelkantam, 1987), the Cuddapah basin is reported to contain 90% of the known barite reserves in India and over 25% of the world reserves,(Nagaraja Rao and others,1987). The deposit at Mangampeta (in the Rajampet RP) is dominantly stratiform and is controlled within a thick package of carbonaceous shales and dark carbonate beds, within the Pullampet

(=Cumbum) formations of the Nallamalai Group. About 70 million tonnes of barite is reported to occur in two lensoid bodies separated by a distance of about 700 meters. The northern lens occurs in the form of a doubly plunging syncline with a strike length of about 1200 meters, a maximum width of 900 meters and an average thickness of 21 meters. The southern lens has a strike length of 300 meters, a width of 220meters and thickness ranging from 4-10 meters. The deposit had been interpreted to be of sedimentary or volcanogenic origin, (Karunakaran, 1973; Neelkantam, 1987). Phelps Dodge geologists (Biczok; Iannelli), however, as brought out later in this report, support a Sedimentary-Exhalative (SEDEX) type environment for the genesis of the stratiform barite deposits of Mangampeta. The overall environment that was conducive for barite formation in restricted periodically oxygenated basins, it has been argued, must be also have genetic relationships with oxygen deficient similar adjoining stratigraphically coeval rocks for the development of lead -zinc mineralisation.

Certain special features of the Mangampeta barite deposits, as brought out by previous workers, (Neelkantam, S; Mem 6, Geol. Soc. Ind.,1987; Raghunandan, K.R., Seminar on Cuddapah Basin, Tirupati, 95; Geol. Soc. Ind., Annual Convention,1995) may be listed as follows:

Granular barite occurs as light to dark grey massive well bedded fine grained type in carbonaceous shales, often with thin intercalations of volcanoclastic – tuffaceous rocks belonging to the upper sections of the Pullampet (Cumbum) Formation. The tuffs comprise a combination of altered glass crystal fragments and lapilli and rosettes of barite. Occasionally, barite lapilli carry inclusions of euhedral feldspar, quartz, tourmaline and zircon. Barite also forms by replacement of quartz and pyrite grains along their margins; and as late thin veins of white, impure crystalline aggregates in tuffaceous rocks.

On a regional scale , there seemed to be an association of magnetite-phyllite beds (with idiomorphic magnetite crystals) within cherts and quartzites. High Lead- Zinc values were reported from the beds possibly indicating exhalative source (V. Subramanium, 1984).

Ragunandan, K R (in T irupati,95) h as s peculated t hat t he presence of volcanic tuffs associated with bedded barite and associated dolerite sills could relate to arc volcanism with possibilities of finding massive sulphides below the barite deposits, which have yet to be tested by drilling. This possibility had also been emphasized in the GSI compilation (1989) on base metal exploration in the Cuddapah basin.

Base metal investigations: The Nallamalai sub-basin hosts several lead- zinc-copper mineralisation zones, some of which were investigated and exploited in the recent past, from within the Cumbum formations as follows:

(i) Agnigundala belt: (North of Badvel R P) The deposits were assessed by the Geological Survey of India and developed by Hindusthan Copper in 1970 (P.K.Ramam,1999; Mineral Resources of Andhra Pradesh) at the following localities in the northern extension of the Nallamalai sub-basin in Guntur District:

- Bandlamottu deposit carrying 1.7 million tonnes with 3.1% Pb and 0.56% Copper.
- Nallakonda deposit carrying 3.14 million tonnes with 1.82% Cu and negligible Pb.
- Dhukonda, 2.614 million tonnes with 1.53 % Cu and 8.98% Pb.

The underground mines essentially developed for lead within Cumbum carbonates produced 1271 tonnes of Lead concentrates in 1975; 3477 tonnes in 1977; a little over 4000 tonnes during 1981 to 1986; about 3500 tonnes during 1987 to 1992; 4690 and 5136 tonnes during 1996 and 1997. The mines are reported to be currently uneconomic and are being closed down. The ores were reported as (a) stratabound lodes concordant to bedding, and also as veins, fracture fillings and disseminations in dolomitic carbonates and calcareous arenites of the Cumbum Formation; (b) as disseminations and stringers controlled along fold closures, and (c) as disconnected masses or disseminations and pockets in dolostones following axial zones and shear intersections.

(ii) Zangamarajupalle area, Cuddapah district:

Lead-Zinc mineralization was investigated by the Geological Survey of India (GSI) and the Mineral Exploration Corporation of India (MECL), in the 50 km,

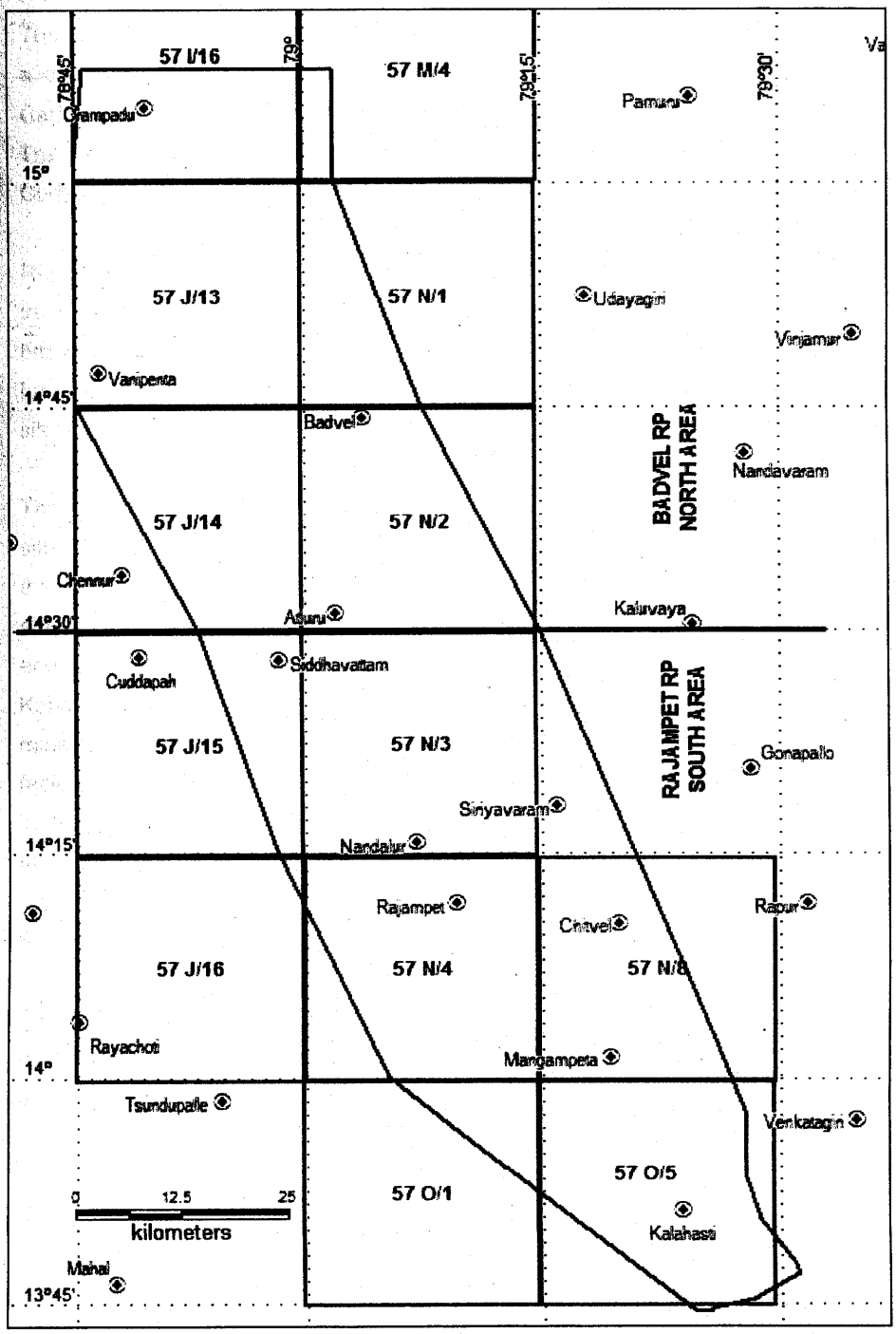
south to north trending belt near Zangamarajupalle - Varikunta within our Badvel RP in Cuddapah district. Soil geochemistry established the presence of a mineralized zone over a strike length of 3.6 kilometers in Cumbum carbonate members or beds. Deposits at Zangamarajupalle and Golapalle were considered important. Other occurrences were reported from Varikunta, Hulurkonda and Karredukuppa. The mineralized zone comprising a strike length of 400 meters in the central section, 600 meters in the southern section and 200 meters in the northern section were reported to be strata-bound in host carbonates (calcarenites) of the Cumbum formation. Sphalerite>galena along with minor pyrite and Chalcopyrite also occur as cavity fillings, breccia fillings and as fine dessiminations apparently following carbonate laminae. The mineralized zones were drill tested by the GSI and MECL as persistant strike-wise and upto 200 meters depth in the central section. Small reserves of Lead and Zinc, carrying 2 – 3 % Zn and less than 2% Pb (with erratic values of 6% Pb) were reported by MECL and GSI. The total reserves in three sections, as reported could be in the range of around three million tonnes.

1.4 Present Work by Phelps Dodge:

While awaiting grant of the Badvel and Rajampet RP's, Phelps Dodge contracted with Perry Remote Sensing Ltd. of Colorado, USA, to acquire a Landsat scene of the entire project area and prepare a georectified, sharpened image from this (Map 1). In addition, a series of Band-ratio images was prepared using Perry's proprietary techniques to outline potential areas of alteration, carbonates and iron-rich rocks. These images were of considerable use in the ensuing mapping program. In addition to this remote sensing data, Phelps Dodge purchased the available government aeromagnetic and electromagnetic (AEM) data from an Operation Hard Rock airborne survey conducted in 1968 and was used to outline probable areas of carbonaceous black shales within the Nallamalai basin. The shales show up as broad areas of conductance on the AEM maps and their predicted distribution based on these maps was generally in good agreement with outcrops mapped in the field.

Upon execution of the two contiguous RP's covering the southern parts of the Nallamalai sub-basin (Figure 2), on 22nd March 2001, a field party headed by

Figure 2: Sketch map of the Rajampet (North Area) and Badvel (South Area) Reconnaissance Permits. The sketch outlines the distribution of 1:50,000 scale topographic map sheets for the field area.



Dr. Thomas Iannelli commenced an exploration program with its base at Tirupati. The main objectives were to assess through regional mapping (Map 2 - in pocket) and reconnaissance in the two contiguous Permit areas the Cumbum (Shale-Carbonate) Formation in terms of its prospectivity for base metal mineralisation. The work in the northern Badvel RP was undertaken after shifting base to Cuddapah.

Rapid traversing in the Rajampet (Southern) RP were with the object of studying the shale-carbonate lithologies of the Cumbum formation in relation to controls of barite and base-metal mineralisation. The area was to be systematically explored for basemetal mineralisation, based on results of geochemical and prospecting, silt stream sediment and well water sampling.

The northern Badvel RP, lithofacies assemblages and related known mineralised sites for base metals in the Cumbum Formation were examined in the vicinity of the villages Zangamarajupalle-Rekalakunta-Kandimallayyapalle, areas located about 40 kilometers northwest of Cuddapah town. The site comprises the south end of Zangamarajupalle-Varikunta base metal belt, falling within the Kanchalamoram Reserved Forest. Work comprised examination of numerous old mine pits, trenches and shafts within Cumbum Carbonates and in the black shale facies. Measured lithostratigraphic sections were compiled for locations near Zangamarajupalle. The preliminary appraisal of the base metal belt did suggest the presence of an extensive mineralizing system with significant alteration patterns associated with the mineralisation in host carbonate rocks. The results of the preliminary investigation are described later in this report.

The second phase of exploration under Dr. Thomas Iannelli comprised reconnaissance prospecting and related lithogeochemical sampling, stream and silt sampling and well water sampling to assess the overall distribution of base metal mineralisation within the Cumbum formations, particularly away from the known Zangamarajupalle-Varikunta belt, within the Rajampet RP. Stream silt and well water sampling programs covered accessible sites exclusively within the Cumbum formations which alone were considered prospective, and ten

anomalous areas were deliniated in the Rajampet RP area for detailed soil geochemical sampling .

All sampling was confined, as before, to the Cumbum formations. Intensive percussion drilling undertaken in this area for ground water by the local farmers was instrumental for understanding the distribution of the graphitic black shale facies within the shale members of the Cumbum Formation, and for examining rock cuttings of fresh unweathered rock in controlled stratigraphic sections in vertical and lateral extensions. The latero- vertical facies variations helped to define third order sub-basins in Survey of India toposheets 57 N/4, N/8 and O/5. Electromagnetic (EM) data obtained from the AMSE wing of the Geological Survey of India relating to the "Operation Hard Rock" (OHR) airborne geophysical surveys, as stated earlier, further helped with correlating and outlining the third order graphitic shale outcrops mapped within the Cumbum Formation, as plotted on Map-2 (Geology on Landsat base). Dr Iannelli in his final report outlined targets for drilling and follow-up work on anomalous prospects, as well as, with recommendations to examine the thickly forested, relatively inaccessible areas to the north of Zangamarajupalle. In the Rajampet RP (South area), direct evidence for base metal mineralisation is limited to gossan zones, geochemical stream sediment and well water anomalies some of which appeared to be lateral extensions of the Mangampeta barite sub-basin where detailed follow-up work has been suggested.

The data and recommendations made by Dr. Iannelli and his group was analyzed by geologists of Phelps Dodge India, in consultation with Mr. Rich Levelle, Chief Geologist and Mr. Steven Enders, President, Phelps Dodge Exploration Corporation (PDX). Prima facie, it appeared that while targets based on rock geochemistry in the Badvel RP indicated the presence of Lead-Zinc mineralisation with some associated copper and silver, the prospects were generally confined to altered often deformed host carbonate rocks probably having a limited aerial extent. In a myriad of such occurrences, a large Sedex type system was not evident from the current results. On the other hand, the Mangampeta barite deposit, in the view of Phelps Dodge geologists, represented

a large truly Sedex type system, locally developed in a third order sub-basin in which the carbonaceous black shale facies formed the trap for the baryte in a restricted but oxygenated (aerobic) exhalative environment. Within the same sub-sub basin, the graphitic black shale beds could be hosts for a large Zinc-Lead deposit below or laterally away (down dip or along strike), where the environment was continuously oxygen deficient. Such blind targets, (since they are not evident from the current prospecting data) as are known to exist elsewhere (Selwyn basin; Red Dog; Goodfellow & others, 1993), would need to be searched in coeaval carbonaceous -calcareous members of Cumbum formation. In the view of the writer of this report, base metal mineralisation observed so far in the Badvel area is perhaps akin to Irish or Mississippi valley type systems where small but high grade deposits may be outlined. Since the objective all through has been for the discovery of large, Phelps Dodge expectation targets (> 2,000,000 tonnes of equivalent copper), the higher priority for prospecting has to be given to the anomalous areas around Mangampet in the Rajampet RP.

The evaluation of the Mangampet area, in terms of its base metal potential was awarded to M/s Intellex Geoscience, represented by Mr. Tony Goddard assisted by Phelps Dodge counterpart geologists. The consultant prepared a 1: 50,000 scale outcrop geology map on which the results of earlier geochem sampling of Iannelli were plotted. The work was, by and large, inconclusive. Biczok (2002) however, utilized the available data to model a possible Sedex type lead-zinc system in relation to the Mangampet barite deposit. The geologic map (Intellex Geoscience) and Biczok's model are incorporated later in this report.

1.5 Expenditure - Committed and Incurred:

Table: 2 Phelps Dodge Exploration India Private Limited.
Expenditure commitments on Badvel and Rajampet RP's

RP Name	Expenditure Commitment (in lakh rupees)			
	1st Year	2nd Year	3rd Year	Total
Badvel RP (North area)	15	20	30	65
Rajampet RP (South area)	15	20	30	65

As per books of accounts of Phelps Dodge India, the following are the total expenditure figures for the two Reconnaissance Permits, Rajampet (South area) & Badvel (North area) upto January, 2004:

Total expenses upto January, 2004

Reconnaissance Permit	Expenditure Incurred (INR)
Rajampet Reconnaissance Permit	Rs. 76,33,772.55
Badvel Reconnaissance Permit	Rs. 22,80,732.07
Total	Rs. 99,14,504.62

The expenditure figures are subject to final audit of accounts . It would be noted that while commitments of Rs 65 lakhs for Rajampet RP have been exceeded, the shortfall in expenditure in the Badvel RP is mainly on account of the low priority accorded to base metal mineralisation targets investigated within host carbonate rocks; several of which had already been investigated in some detail through drilling programmes conducted earlier by the Geological Survey of India (GSI). The GSI did not find any of the mineralized zones to carry economically potential reserves.