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Base metal deposits in the Adharshila-Dariba Block, Neem Ka Thana Region, Rajasthan are affected by terrain and rock formations.

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Abstract
In the Neem Ka Thana area of Rajasthan, the Adharshila-Dariba block is a major metallogenic province in the Mesoproterozoic Delhi Supergroup. Through in-depth geological mapping and exploring data analysis, this study looks at how structure and lithology affect the mineralisation of base metals, especially copper-silver deposits. Mineralisation in the area is mostly controlled by sedimentary layers in the North Delhi Fold Belt. The mineralisation is both stratiform and stratabound. The copper mineralisation is made up of groups that are mostly boronite, and the silver values that are found with them can reach economically important levels. Structure study shows that NE-SW trending folds and fault systems control where the ore is found, and that certain lithological units in the Delhi Supergroup make good host rocks. The mineralisation is like both sediment-hosted stratiform copper deposits and Iron Oxide Copper Gold (IOCG) systems, which means the environment is complicated and multimetallic. This study helps us learn more about how the Proterozoic base metal deposits in the Indian shield formed and can be used to plan future exploration tactics in similar geological areas.

Keywords: Base metal deposits, Delhi Supergroup, Structural geology, Bornite, Copper mineralization, Rajasthan

1. Introduction

The Delhi Supergroup in northwest India is one of the most important Mesoproterozoic metallogenic areas in the Indian subcontinent. It is home to many economically important base metal deposits (Sinha et al., 1998; Sinha, 2000). Neem Ka Thana is in Sikar District, Rajasthan, and is part of the North Delhi Fold Belt. It has a number of well-known copper-silver mines that have been of great interest to geologists since the early 1900s (Heron, 1917, 1923). Adharshila-Dariba block is an important part of this metallogenic belt. It has complicated structure geology and different lithological assemblages that control the mineralisation of base metals. Copper mineralisation and related valuable metals, especially silver, have been found in large amounts in certain layers of the Delhi Supergroup in previous studies (Sharma et al., 2014, 2015; Mukhopadhaya, 2004, 2014). The Delhi Supergroup's natural history goes back about 1.8 to 1.0 Ga. During this time, it went through several stages of sedimentation, deformation, and metamorphism that made it possible for ore to form (Singh, 1988). The complicated structure of the area, which includes polyphase deformation and multiple fold generations, has had a big effect on where mineralised zones are found and how they are shaped (Ray, 1983; Sharma & Mondal, 2016). New research suggests that the copper deposits in the Neem Ka Thana area might be sediment-hosted stratiform deposits that are similar to deposits found in other Proterozoic landscapes around the world (Mukhopadhaya et al., 2019). But some experts have also come up with an Iron Oxide Copper Gold (IOCG) model for some deposits. This shows how complicated the processes that make metals in the area are (Sharma et al., 2020). The goal of this study is to give a full look at how the structure and lithology of the Adharshila-Dariba block affect the mineralisation of base metals. It will do this by combining decades of exploration data and geological investigations to get a good idea of how ore forms and where it is found.

2. Geological Setting

2.1 Regional Geology

The study area is situated within the North Delhi Fold Belt, which forms part of the larger Delhi Mobile Belt in northwestern India. The regional geology is dominated by rocks of the Delhi Supergroup, a thick sequence of metasedimentary and metavolcanic rocks deposited during the Mesoproterozoic era (Geological Survey of India, 2011). The Delhi Supergroup in the region is subdivided into several formations, including the Khetri Formation, which hosts significant copper mineralization, and associated volcanic and sedimentary units. The regional structural trend is predominantly NE-SW, reflecting the dominant fold axes and fault systems that control the overall architecture of the belt (Sinha et al., 1998).

2.2 Local Stratigraphy

Within the Adharshila-Dariba block, the stratigraphic sequence consists of multiple lithological units arranged in a complex structural framework. The primary host rocks for base metal mineralization include:

1. **Quartzite and Schist Units:** These form the dominant lithological assemblage, with varying degrees of metamorphism and deformation.
2. **Carbonate Horizons:** Localized carbonate units provide important geochemical environments for ore deposition.
3. **Volcanic and Volcaniclastic Rocks:** These units contribute to the overall metal budget and provide structural controls.
4. **Intrusive Bodies:** Granitic and basic intrusions influence local thermal and hydrothermal processes.

2.3 Structural Framework

The structural geology of the region is characterized by multiple deformation phases, resulting in complex fold interference patterns and fault systems. The primary structural elements include:

- **F1 Folds:** Early isoclinal folds with axial traces trending NE-SW
- **F2 Folds:** Open to tight folds superimposed on F1 structures
- **Fault Systems:** Both thrust and normal faults with varying orientations
- **Shear Zones:** Ductile shear zones that localize mineralization

3. Methodology

3.1 Data Compilation

This study synthesizes geological and exploration data from multiple sources, including reports from the Geological Survey of India (GSI) spanning from the 1960s to recent investigations. The data compilation includes:

- Geological mapping reports at various scales
- Drilling and exploration data
- Geochemical analysis results
- Structural measurements and orientation data
- Mineralogical and petrological studies
-

3.2 Analytical Approach

The analytical methodology involved:

1. **Structural Analysis:** Compilation and interpretation of structural data to understand deformation patterns and their relationship to mineralization.
2. **Lithological Correlation:** Detailed correlation of rock units across the study area to establish stratigraphic controls.

3. **Geochemical Data Analysis:** Statistical analysis of geochemical data to identify element associations and zonation patterns.
4. **Spatial Analysis:** GIS-based analysis of the spatial distribution of mineralization relative to geological features.

4. Results and Discussion

4.1 Structural Controls on Mineralization

The structural analysis reveals that base metal mineralization in the Adharshila-Dariba block is primarily controlled by the intersection of multiple structural elements. The dominant NE-SW trending fold axes provide first-order controls on ore distribution, while secondary structures create localized zones of enhanced permeability and fluid flow.

Table 1: Structural Elements and Their Relationship to Mineralization

Structural Feature	Orientation	Mineralization Control	Economic Significance
F1 Fold Axes	N45°E - N60°E	Primary ore alignment	High
F2 Fold Axes	N20°E - N35°E	Secondary concentration	Moderate
Thrust Faults	N30°E / 45°SE	Ore remobilization	High
Normal Faults	N-S / 60°W	Late stage disruption	Low
Shear Zones	NE-SW / Sub-vertical	Fluid channeling	Very High

The intersection of fold hinges with fault systems creates particularly favorable sites for ore concentration. Field observations and drilling data indicate that the highest-grade mineralization occurs at these structural intersections, where multiple phases of deformation have created enhanced porosity and permeability (Sharma et al., 2014).

4.2 Lithological Controls

The lithological analysis demonstrates that specific rock units within the Delhi Supergroup sequence act as preferential hosts for base metal mineralization. The most significant host rocks include:

4.2.1 Quartzite-Schist Assemblages

These units provide the primary host environment for copper-silver mineralization. The alternating beds of competent quartzite and incompetent schist create structural traps that localize ore-bearing fluids during metamorphism and deformation Mukhopadhaya, 2014).

4.2.2 Carbonate Horizons

Localized carbonate units serve as important geochemical traps, facilitating sulfide precipitation through pH buffering and sulfur saturation mechanisms. These horizons often show the highest copper grades and are associated with significant silver values (Mukhopadhaya et al., 2019).

Table 2: Lithological Units and Associated Mineralization

Rock Type	Copper Grade (%)	Silver Grade (g/t)	Primary Minerals	Alteration Style
Quartzite	0.5 - 2.1	15 - 45	Chalcopyrite, Bornite	Silicification
Schist	0.8 - 3.2	25 - 78	Bornite, Chalcocite	Sericite, Chlorite
Carbonate	1.2 - 4.5	35 - 125	Bornite, Native Silver	Dolomitization
Volcanic	0.3 - 1.8	8 - 32	Chalcopyrite, Pyrite	Propylitic

4.3 Mineralogical Characteristics

The ore mineralogy is dominated by bornite (Cu5FeS4), which constitutes the primary copper-bearing phase throughout the deposit. This mineralogical characteristic distinguishes the Adharshila-Dariba deposits from typical porphyry or VMS systems and supports a sediment-hosted stratiform model (Sharma et al., 2020).

4.3.1 Primary Ore Minerals

- **Bornite:** Dominant copper mineral (60-80% of copper-bearing phases)
- **Chalcopyrite:** Secondary copper mineral (15-25%)
- **Chalcocite:** Minor copper mineral (5-10%)
- **Native Silver:** Significant precious metal phase
- **Pyrite:** Dominant iron sulfide

4.3.2 Gangue Minerals

The gangue mineralogy reflects the host rock lithology and metamorphic grade:

- Quartz, feldspar, and mica from quartzite-schist assemblages
- Carbonate minerals (dolomite, calcite) from carbonate horizons
- Chlorite, epidote, and actinolite from alteration processes

4.4 Geochemical Zonation

Geochemical analysis reveals distinct metal zonation patterns that reflect both primary depositional processes and subsequent metamorphic redistribution. The zonation shows

4.4.1 Core Zone

- High Cu (1.5-4.5%)
- High Ag (25-125 g/t)
- Elevated Pb and Zn
- Bornite-dominated assemblage
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4.4.2 Intermediate Zone

- Moderate Cu (0.8-2.1%)
- Moderate Ag (15-45 g/t)
- Chalcopyrite-bornite assemblage
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4.4.3 Peripheral Zone

- Low Cu (0.2-0.8%)
- Low Ag (5-20 g/t)
- Pyrite-chalcopyrite assemblage
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Table 3: Geochemical Zonation Pattern

Zone	Distance from Core (m)	Cu (%)	Ag (g/t)	Pb (ppm)	Zn (ppm)	Dominant Sulfides

Core	0-150	2.8±1.2	65±28	850±320	1200±450	Bornite
Intermediate	150-400	1.4±0.6	32±15	420±180	680±220	Bornite-Chalcopyrite
Peripheral	400-800	0.6±0.3	18±8	180±75	320±125	Chalcopyrite-Pyrite
Background	>800	0.2±0.1	8±4	85±35	150±60	Pyrite

4.5 Deposit Genesis Model

Based on the integrated analysis of structural, lithological, and geochemical data, a comprehensive genetic model for the Adharshila-Dariba deposits can be proposed:

4.5.1 Syngenetic Phase Initial metal accumulation occurred during sedimentation within specific stratigraphic horizons of the Delhi Supergroup. The presence of organic matter and sulfur-rich environments facilitated early sulfide precipitation.

4.5.2 Diagenetic Phase During burial diagenesis, metal remobilization and concentration occurred through pore fluid migration and chemical reactions with host sediments.

4.5.3 Metamorphic Phase Regional metamorphism resulted in recrystallization of ore minerals and development of the characteristic bornite-dominated assemblage. Structural controls became increasingly important during this phase.

4.5.4 Hydrothermal Overprinting Late-stage hydrothermal activity, possibly related to intrusive events, resulted in local upgrading of mineralization and introduction of precious metals.

4.6 Economic Implications

The structural and lithological controls identified in this study have significant implications for exploration and resource evaluation:

4.6.1 Exploration Targeting

- Priority areas should focus on fold hinge zones and fault intersections
- Carbonate horizons within the stratigraphic sequence represent high-priority targets

- Geochemical surveys should emphasize Cu-Ag-Pb-Zn association patterns

4.6.2 Resource Continuity The stratiform nature of mineralization suggests good lateral continuity along favorable stratigraphic horizons, supporting the potential for significant resource expansion

4.6.3 Metallurgical Considerations The bornite-dominated ore mineralogy may require specific beneficiation approaches different from conventional chalcopyrite-dominated deposits.

5. Comparative Analysis

5.1 Regional Comparison

Comparison with other deposits in the Delhi Supergroup reveals both similarities and distinctive features:

Table 4: Comparison with Regional Deposits

Deposit	Primary Cu Mineral	Ag Grade (g/t)	Host Rock	Structural Control
Adharshila-Dariba	Bornite	25-125	Quartzite-Schist	Fold-Fault Intersection
Baniwala-Dokan	Bornite	35-95	Schist	Shear Zone
Baleshwar	Chalcopyrite	15-55	Quartzite	Fold Hinge
Khetri	Chalcopyrite	20-65	Schist	Thrust Fault

5.2 Global Analogues

The Adharshila-Dariba deposits show similarities to other Proterozoic sediment-hosted copper deposits worldwide, including:

- Mount Isa deposits (Australia): Similar bornite dominance and stratigraphic control

- Kupferschiefer deposits (Europe): Comparable metal zonation patterns
- Central African Copperbelt: Analogous structural and lithological controls

6. Conclusions

This comprehensive study of the Adharshila-Dariba block reveals that base metal mineralization is controlled by a complex interplay of structural and lithological factors:

1. **Structural Controls:** The intersection of NE-SW trending folds with fault systems provides primary controls on ore distribution, creating zones of enhanced permeability and fluid flow.
2. **Lithological Controls:** Specific rock units within the Delhi Supergroup, particularly quartzite-schist assemblages and carbonate horizons, act as preferential hosts for mineralization.
3. **Mineralogical Characteristics:** The bornite-dominated ore mineralogy distinguishes these deposits from typical porphyry systems and supports a sediment-hosted stratiform model.
4. **Geochemical Zonation:** Distinct metal zonation patterns reflect both primary depositional processes and subsequent metamorphic redistribution.
5. **Genetic Model:** A multi-stage genetic model involving syngenetic, diagenetic, metamorphic, and hydrothermal processes best explains the observed characteristics.
6. **Economic Significance:** The structural and lithological controls identified provide important guidelines for exploration targeting and resource evaluation.

References

1. Agrawal, R. C., & Kumar, V. (1982). Ganeshwar-Jodhpur Culture: New Traits in Archaeology. In G. L. Possehl (Ed.), *Harappan Civilization* (pp. 125-134). Oxford and IBH Publishing.
2. Agrawal, R. C. (1984). Aravalli the Major Source of Copper for the Indus Civilization and Indus Related Cultures. In B. B. Lal & S. P. Gupta (Eds.), *Frontiers of the Indus Valley Civilization* (pp. 157-162). Indian Archaeological Society.
3. Barton, P. B. (1970). Sulphide Petrology. *Mineralogical Society of America Special Papers, 3*, 187-198.
4. Behera, K. K. (2008). STM of Delhi Super Group of Rocks in Dariba-Toda Area, Sikar District Rajasthan with Special Emphasis of Locating New Zones of Copper Mineralization. *Unpublished GSI WR Report F.S. 2006-2007*.

5. Behera, K. K., Mukhopadhaya, S., Kumar, P., Sarkar, S., & Srivastava, P. C. (2007). STM of Delhi Super Group of Rocks in Neem ka Thana-Raipur-Patan Area, Sikar District, Rajasthan with Special Emphasis on Locating New Zones of Base Metal Mineralization. *Unpublished GSI WR Report F.S. 2004-2006*.
6. Bhat, M. L. (1970). Report on the Geological Mapping of the Raipur-Toda Area, Sikar and Jaipur District, Rajasthan. *Unpublished GSI WR Report F.S. 1968-1969*.
7. Bhaise, M. S. (2014). Investigation for Base Metal in Dariba North Block, Sikar District, Rajasthan. *Unpublished GSI WR Report F.S. 2012-2014*.
8. Boopathi, D. (2010). Investigation for Base Metals and Associated Noble Metals in Baleshwar-Dariba Belt, Sikar District, Rajasthan. *Unpublished GSI WR Report F.S. 2006-2007*.
9. Brahma, S. J. (2017). Exploration for Base Metal in Dhabala Block, Sikar District, Rajasthan. *Unpublished GSI WR Report F.S. 2016-2017*.
10. Brahma, S. J., & Gupta, S. (2015). Investigation for Base Metal in South-East of Kharagbinjpur, Sikar District, Rajasthan. *Unpublished GSI WR Report 2014-2015*.
11. Chattopadhayay, S., & Mukhopadhaya, S. (2007). Petro-Mineralogical and Fluid Inclusion Studies in Baniwala ki Dhani-Dokan Area, Sikar District, Rajasthan. *Unpublished GSI Report*.
12. Dasgupta, D. J. (1989). A Note on the Preliminary Investigation of Bismuth Occurrences in Narda and Neem ka Thana Areas, Sikar District, Rajasthan. *Unpublished GSI WR Report F.S. 1987-1988*.
13. Debnath, S., Javaid, Z. A., & Dewangan, S. (2018). G-2 Stage Exploration for Base Metal in Toda Ramliyas Block, Sikar District, Rajasthan. *Unpublished GSI WR Report F.S. 2016-2017*.
14. Geological Survey of India. (2011). *Geology and Mineral Resources of Rajasthan* (3rd ed.). Miscellaneous Publication No. 30, Part 12.
15. Greybeal, F. T. (1973). Copper Manganese and Zinc in Coexisting Mafic Minerals from Laramide Intrusive Rocks in Arizona. *Society of Economic Geologists, 68*, 785-798. https://doi.org/10.2113/gsecongeo.68.6.785