

Integrated Geological, Geochemical, and Reserve Estimation of the Gwani Talc Deposit, Darchula, Nepal

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Abstract: Talc occurrences in the Lesser Himalaya are associated with carbonate-rich rocks, and their economic viability depends on mineral quality, deposit continuity, grade, accessibility, overburden thickness, and extraction conditions. This study evaluates talc occurrences in Gwani, Sailesikhar Municipality, Darchula District, Sudurpashchim Province, Nepal, through geological mapping, sampling, chemical analysis, site-suitability scoring, and volume estimation. The deposit occurs within dolomite of the Galyang Formation of the Lesser Himalayan Midland Group, associated with limestone, slate, and schist. The site-suitability assessment gave Gwani a score of 18/24. Fifteen samples yielded SiO₂ contents of 59.36–65.59% (mean ≈ 61.9%) and MgO contents of 28.29–35.65% (mean ≈ 32.5%), indicating low- to medium-grade talc. Six geological cross-sections gave an estimated 2,631,219 m³ (7,104,290 tonnes) of talc and 1,121,934 m³ (3,052,781 tonnes) of associated dolomitic muck. A semi-mechanised mine plan with benching and sequential extraction, assuming 1,600 tonnes/day of combined material over 300 working days per year, gives a mine life of about 21 years. The findings demonstrate the potential for systematic development of industrial talc resources through integrated geological, geochemical, and mine-planning approaches.

Keywords: Talc, Geological characterization, Galyang Formation, Mineral quality, Reserve estimation, Mine planning, Darchula

Introduction

The geology of the Himalayan region is characterized by complex lithological settings (Dhital, 2015; Tiwari et al., 2024), in which deposit continuity, host-rock relationships, surface conditions, and accessibility strongly influence mineral extraction. Talc commonly occurs in association with magnesium-rich carbonate rocks, and its economic potential depends on mineral quality as well as the geometry and accessibility of the deposit.

The study focuses on the talc deposit at Gwani in Sailesikhar Municipality of Darchula District, Sudurpashchim Province, Nepal (Figure 1). The detailed investigation was undertaken around Gwani, where the selected site is accessible from the Mahakali Highway. The study aims to characterize the geological setting and occurrence of the talc, assess its mineral quality, evaluate site suitability using a field-based framework,

estimate the reserve, and develop a preliminary mine plan for the suitable site.

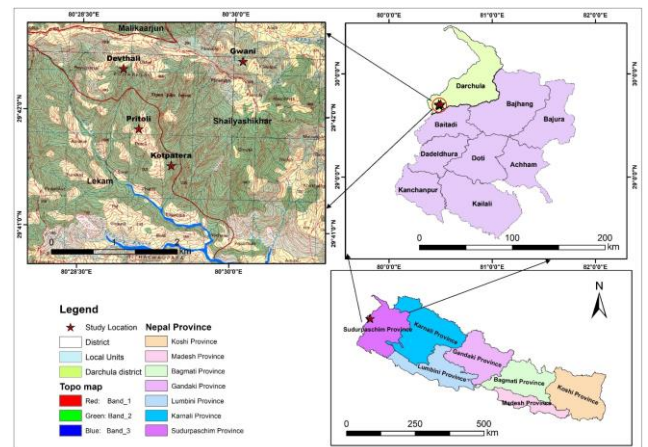


Figure 1, Location map of the Darchula study area and investigated talc occurrences.

Methodology

The investigation followed a workflow of desk study, field study, laboratory testing, and interpretation (Figure 2). Existing geological information, satellite imagery, topographic data, and previous reports were reviewed. Fieldwork comprised geological mapping (Figure 3), route mapping, measurement of bedding attitudes, documentation of lithological contacts and talc exposures, and collection of representative samples. Fifteen talc samples were collected for laboratory characterization.

Site suitability was evaluated using six parameters: slope angle, visual extension of the deposit, talc grade, accessibility of the mine site, land use/land cover, and overburden thickness. The parameters were weighted equally and scored on a four-class suitability scale, giving a maximum total score of 24. Route mapping along approximately 1.105 km (Figure 4) was combined with geological observations and six cross-sections to estimate the geometry and volume of talc and associated dolomitic muck. A phased mine plan was then developed based on bench design, haulage-road requirements, and sequential extraction.

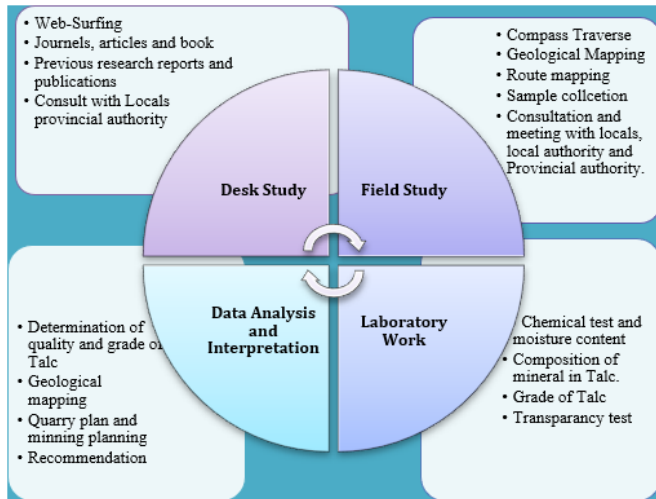


Figure 2, General methodological framework of the study.

Result

The investigated area lies within the Galyang Formation of the Lesser Himalayan Midland Group. The local sequence comprises dark grey shale, calcareous slate, sandstone, limestone, dolomite, slate and schist. Talc occurs mainly within dolomite and is exposed as white, translucent and greasy material; the bed dip predominantly south to southwest. At the Gwani site, talc occurs over a relatively extensive area, locally beneath overburden and within weathered dolomite.

Chemical analysis of 15 samples gave SiO_2 contents of 59.36–65.59% (mean $\approx$ 61.9%) and MgO contents of 28.29–35.65% (mean $\approx$ 32.5%). Moisture ranged from 0.90 to 1.56%, Fe_2O_3 from 1.01 to 1.66%, and Al_2O_3 from

2.35 to 4.92%. Based on these results, the Gwani material is classified as low- to medium-grade talc.

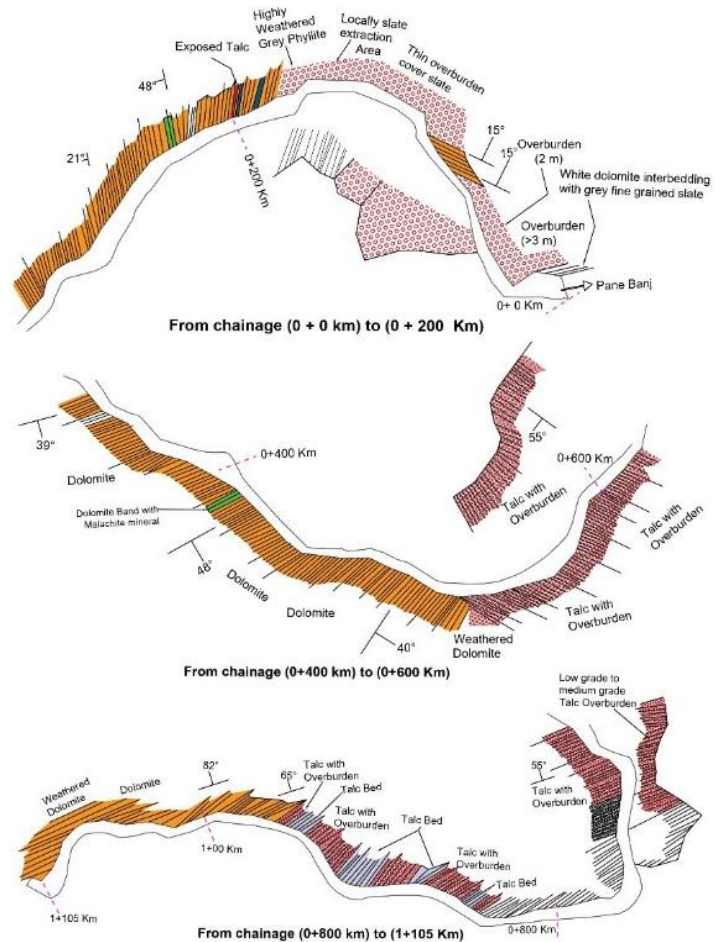


Figure 3, Geological route map of the Gwani talc deposit site, Darchula.

Table 1, Period (year wise) volume calculations of the talc mineral and dolomite.

Section	Materials	Volume (First 5 years)		Volume (5 - 10 years)		Volume (10 - 21 years)	
		Cu. m	Tonnage	Cu. m	Tonnage	Cu. m	Tonnage
AA'	Talc	83,914	226,569	432,956	1,168,980	432,956	1,168,980
	Dolomite	110,792	299,139	110,792	299,139	443,168	1,196,554
BB'	Talc	17,808	48,081	314,945	850,350	314,945	850,350
	Dolomite	13,950	37,665	13,950	37,665	55,800	150,660
CC'	Talc	83,117	224,415	692,610	1,870,048	692,610	1,870,048
	Dolomite	26,059	70,360	26,059	70,360	104,237	281,439
DD'	Talc	12,563	33,919	448,947	1,212,157	448,947	1,212,157
	Dolomite	32,914	88,867	32,914	88,867	131,655	355,468
EE'	Talc	11,823	31,921	419,509	1,132,673	419,509	1,132,673
	Dolomite	66,116	178,514	66,116	178,514	264,465	714,056
FF'	Talc	32,216	86,982	322,253	870,082	322,253	870,082
	Dolomite	30652.3	82,761	30652.3	82,761	122609.2	331,045

Table 2, Volume calculation in each formation of the study area.

Section	Area (sq. m)		Strike length (m)	Volume (cu. m)		Volume (Tonnage)	
	Talc	Muck		Talc	Muck	Talc	Muck
AA'	2,706	2,770	160	432,956	443,168	1,168,980	1,152,238
BB'	2,100	372	150	314,945	55,800	850,350	156,240
CC'	4,617	695	150	692,610	104,237	1,870,048	291,862
DD'	2,721	798	165	448,947	131,655	1,212,157	368,633
EE'	2,425	1,529	173	419,509	264,465	1,132,673	740,503
FF'	3,223	1,226	100	322,253	122,609	870,082	343,306
	17,791	7,389	Total	2,631,219	1,121,934	7,104,290	3,052,781
	Area (sq.m)	25,181				Total	10,157,072

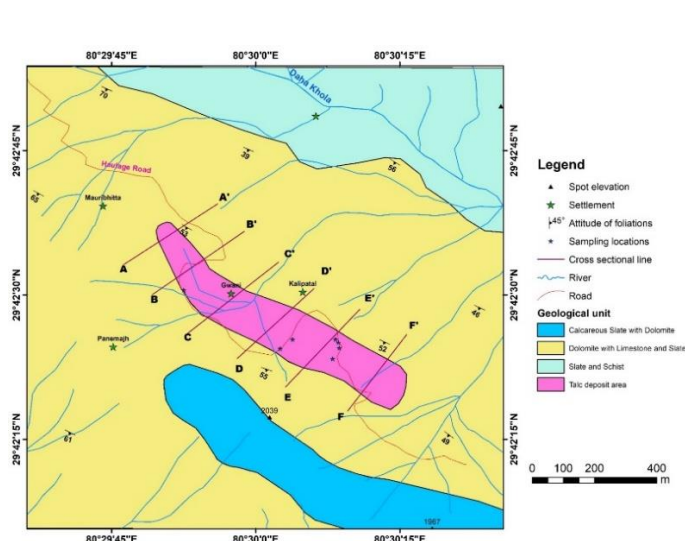


Figure 4, Geological map showing the Gwani talc deposit and surrounding lithological units.

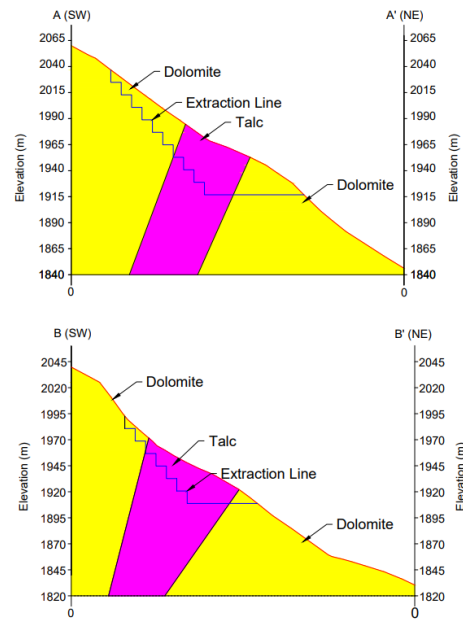


Figure 5, Graphical representation of volume extraction of sections A-A' and B-B'.

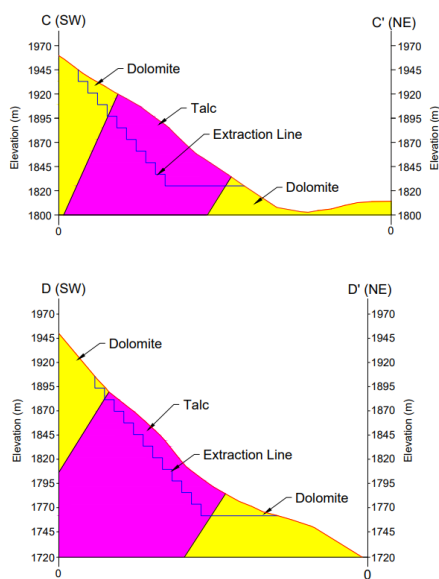


Figure 6, Graphical representation of volume extraction of sections C-C' and D-D'.

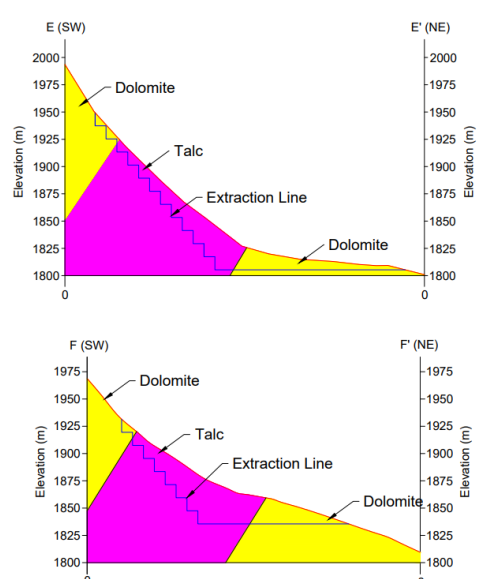


Figure 7, Graphical representation of volume extraction of sections E-E' and F-F'.

The site-suitability assessment gave Gwani a score of 18/24. This score reflects the relatively large lateral extent of the deposit, its reported grade, road accessibility, and manageable overburden. Cultivated land, settlement, and forest cover within the site remain constraints.

The volume of talc and associated dolomitic muck was estimated from six geological cross-sections (A-A' to F-F'), shown in Figures 5-7. The sections give approximately 2,631,219 m³ (7,104,290 tonnes) of talc and 1,121,934 m³ (3,052,781 tonnes) of muck (Table 2). The proposed mine plan divides extraction into phases and applies bench development with sequential advancement (Table 1). At a production rate of approximately 1,600 tonnes/day of combined material over 300 working days per year, the estimated mine life is about 21 years. The dolomitic muck is proposed for use as construction material, which reduces the volume requiring disposal.

Conclusion

The study demonstrates that the Gwani occurrence represents the principal talc target among the investigated sites in Darchula based on its relatively greater deposit extension, material quality, accessibility, and estimated reserve. Integration of geological mapping, laboratory characterization, suitability evaluation and cross-sectional volume estimation provides a practical basis for preliminary mine planning. The reported chemical composition and reserve indicate potential for development of a talc extraction operation, while cultivated land, forest and settlement within the mine area require careful environmental and social management. Further detailed mine design, grade-control drilling and sampling, and confirmation of the reserve during subsequent development are recommended before full-scale production.

Acknowledgement

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