

Geology and Geological Structure of Potash and Rock Salt Deposits in Chalerm Phrakiat District, Nakhon Ratchasima Province in Northeastern Thailand

Parkorn Suwanich

ABSTRACT

Potash and rock salt minerals were examined from core holes drilled by the Department of Mineral Resources, Thailand in Chalerm Phrakiat district, Nakhon Ratchasima province in Northeast Thailand. In total, 7 boreholes were studied to explain the geology and geological structure of the potash and rock salt deposits. There were two beds of rock salt that made up the Middle and Lower Rock Salt units. However, some holes were found only in the Lower Salt bed. The potash minerals found only in the Lower Salt bed were both low grade “carnallite” and high grade “sylvite”, (one of the major K-elements used to produce chemical fertilizer), as well as the magnesium mineral “tachyhydrite”. The geological structure observed in the cross section of each borehole showed facies of potash and rock salt in the area. The carnallite and tachyhydrite were deposited in the local salt basin, whereas the rock salt had formed as a ridge, dome or pillow of the salt layer. The sylvite mineral (the best potash mineral for agricultural fertilizer) was deposited between these two structures or at the flank of the dome or pillow. This information supports the salt dome theory that explains the origin of sylvite deposited in Thailand.

Keywords: geological structure, rock salt, carnallite, sylvite, salt dome

INTRODUCTION

This project aimed to study the geology and geological structure of the potash and rock salt in Northeast Thailand. This reserve of potash mineral can be developed to supply the raw material used in chemical fertilizer.

The geology and geological structure of rock salt and potash deposits can be determined for comparison with other areas. Alternatively, the results can be used for a study of the dome theory of rock salt.

The study area is located near the Friendship Highway in Chalerm Phrakiat district, Nakhon Ratchasima province in the Khorat Basin about 16 km northeast of the city of Nakhon Ratchasima (Khorat) (Figure 1).

Seven core holes were drilled distributed over about 9 km². The core holes (identified as K-19, 101, 102, 103, 104, 105 and 106 in Figure 1) were drilled by the Department of Mineral Resources (DMR), Thailand to explore the potash and rock salt deposits in Northeast Thailand (Japakasetr, 1980, 1981).

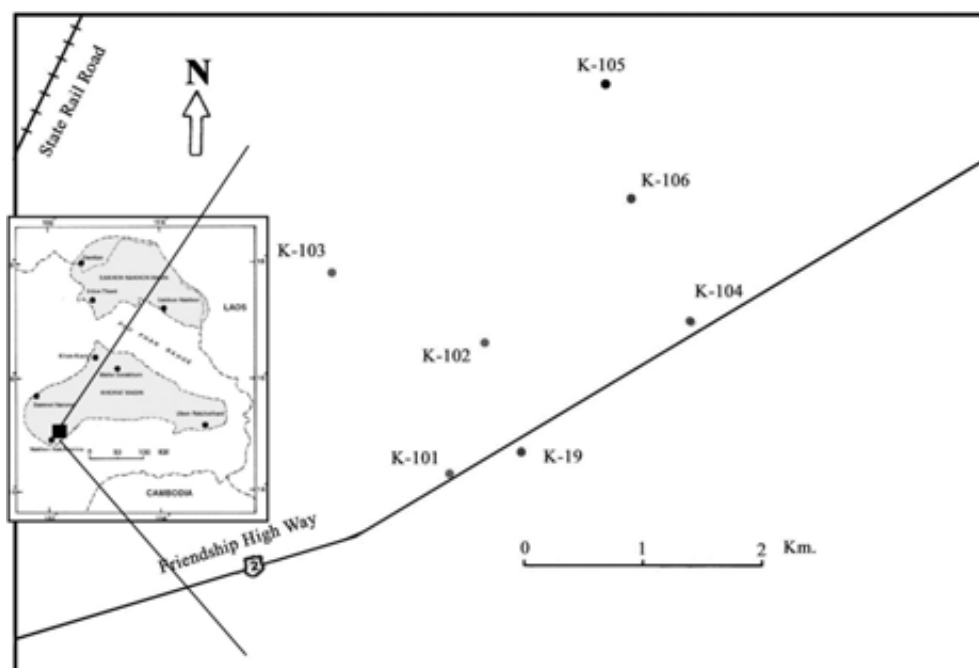


Figure 1 Bore hole locations: K-19, K-101, K-102, K-103, K-104, K-105 and K-106 in the Chalerm Phrakiat area (modified from Japakasetr, 1982).

The rock salt and potash beds are arranged in the Maha Sarakham Formation (Fm.) that is composed of three salt beds, and one potash bed mainly in the Lower Salt bed. This formation is enclosed by the Phutok (upper part) and Khok Kruat (lower part) Fm. (Japakasetr, 1980, 1981).

MATERIALS AND METHODS

The data for the study was sourced from an examination of the results from core holes drilled by the DMR in this area. The data from the core holes was analyzed and compared using the geological technique of geological correlation. A fence diagram was used to study the geology and geological structure of potash and rock salt deposits in the area.

Tables 1-7 summarize the results of the core logs obtained using a diamond bit.

RESULTS AND DISCUSSION

The core logs showed that the bedding of the lower salt layer has a tendency to dip gently to the northeast toward the central Khorat Basin. The direction of the lower salt base dipping is normal and has a slope of about 7-10 m/km, so it is rather flat.

According to the general geology of the Maha Sarakham Fm., the geology of the Chalerm Phrakiat area has only two salt beds, called the Middle and Lower Salt; whereas the Upper Salt has disappeared. The two-salt-beds were encountered with the K-102 and K-104 boreholes, whereas only one salt bed was encountered with the remaining holes (K-19, K-101, K-103, K-105 and K-106). The holes which found only the Lower Salt and had no overlying potash zone, indicated that the salt had flowed up as a dome until the potash zone had been dissolved completely, with no thick upper clastic covering.

Table 1 Log of hole K-19 (revised and modified from Japakasetr, 1982).

Core interval (m)		Thick ness (m)	Rock Fm./Unit	Rock type	Description	
From	To					
0.00	45.11	45.11	Top Soil	Sand	Unconsolidated loose brownish gray, reddish brown sand, fine-coarse grained, with some laterite grained in upper level.	
45.11	78.33	33.22	Phutok Fm.	Claystone	Hard bed of light reddish brown with some green spots, hard, fragmented pieces.	
78.33	85.34	7.01	Maha Sarakham Fm.	Lower clastic	Clay	Stiff clay, reddish brown to gray color.
85.34	88.62	3.28		Cap anhydrite	Anhydrite	Grayish white with thin banded black organic, thin lenticular and curve shape of fragments.
88.62	205.03	116.41		Lower rock salt	Rock salt	Mostly glassy, vitreous and colorless halite, some smoky and milky white grained. Thin laminate anhydrite found in some intervals.
205.03	205.79	0.76		Basal anhydrite	Anhydrite	Grayish white, massive at the bottom but upper part similar to cap anhydrite.
205.79	206.25	0.46	Khok Kruat Fm.	Siltstone	Grayish green, massive.	
206.25	219.45	13.20		Sandstone	Reddish brown, massive.	

Table 2 Log of hole K-101 (revised and modified from Japakasetr, 1982).

Core interval (m)		Thick ness (m)	Rock Fm./Unit	Rock type	Description	
From	To					
0.00	16.76	16.76	Top Soil	Clay	Unconsolidated yellowish gray clay about 70% with fine to medium sand grained 30% and some rock fragments.	
16.76	54.86	38.10	Alluvium	Clay & sand	Unconsolidated clay and sand interlayering, clay is dark gray and some reddish brown, sand is fine to medium round to sub-round, well sorted.	
54.86	68.70	13.84	Maha Sarakham Fm.	Lower clastic	Clay	Stiff dark reddish brown with some dark gray interlayering and spotted. White gypsum veins found in fractures.
68.70	78.67	9.97		Cap anhydrite	Gypsum & anhydrite	Upper part (about 3 m) is sugary, vitreous gypsum whereas the rest is white gray anhydrite. Both parts are interbanded by black organic stripes.
78.67	199.64	120.97		Lower salt	Rock salt	Mostly glassy, vitreous and colorless halite, some smoky and milky white grained. Thin laminate anhydrite found in some intervals. <u>Note:</u> Drilling stopped in this rock salt bed.

Table 3 Log of hole K-102 (revised and modified from Japakasetr, 1982).

Core interval (m)		Thickness (m)	Rock Fm./Unit	Rock type	Description	
From	To					
0.00	9.14	9.14	Top Soil	Clay	Unconsolidated brownish gray clay with some fine sand and lateritic grain.	
9.14	42.75	33.61	Phutok Fm.	Claystone	Hard bed rock of brick reddish brown claystone to siltstone with some white gypsum and anhydrite veins and veinlets.	
42.75	47.09	4.34	Maha Sarakham Fm.	Upper salt (remained)	Cap gypsum & anhydrite	Sugary, vitreous gypsum interbedded with white gray anhydrite, all interbanded by black organic stripped in mostly horizontal layers.
47.09	93.50	46.41		Middle clastic	Clay	Stiff dark reddish brown with some small dark gray spots and layers. Some gypsum and anhydrite cut in the massive rock.
93.50	96.52	3.02		Middle salt	Anhydrite	White gray with some black strips secondary anhydrite with porous texture.
96.50	97.96	1.44			Rock salt	Mostly pale brown and pale orange halite and smoky dark halite interbedded with thin stripped anhydrite.
97.96	99.16	1.20			Anhydrite	White gray to dark gray, massive and hard layer.
99.16	114.68	15.52			Rock salt	Pale brown to pale orange halite with some gray and reddish orange halite at the bottom part.
114.68	142.10	27.42		Lower clastic	Clay	Mostly stiff dark reddish brown with some dark gray mottling. The bottommost is dark gray. Some fractures are filled with clear halite grained.
142.10	143.33	1.23		Color salt	Rock salt	Several color band of gray, orange, red and smoky dark harder halite.
143.33	146.23	2.90		Potash zone	Carnallite	20% or reddish orange and pink carnallite interlocking grained with colorless halite.
146.23	160.17	13.94			Tachyhydrite	Almost pure yellowish orange tachyhydrite with some deep orange carnallite and colorless halite interlocking grained.
160.17	167.89	7.72			Carnallite	Mostly pink to violet red with some orange grained carnallite with some tachyhydrite grained. Some dull white boracites found. Colorless halite interlocking grain together.
167.89	219.21	51.32		Lower salt	Rock Salt	Upper part is clear colorless halite with some anhydrite small-chip layer interbedding, in the lower part the halite more dirtily with smoky dark and milky white grained as well as more increasing anhydrite chips. Bedding mostly in horizontal bed.
219.21	220.70	1.49		Basal anhydrite	Anhydrite	Grayish white, massive and boundinage structure. at the bottom but upper part similar to cap anhydrite.
220.70	220.98	0.28		Khok Kruat Fm.	Siltstone	Grayish green, massive.
220.98	224.03	3.05			Sandstone	Reddish brown, massive.

Table 4 Log of hole K-103 (revised and modified from Japakasetr, 1982).

Core interval (m)		Thick ness	Rock Fm./Unit	Rock type	Description	
From	To	(m)				
0.00	4.57	4.57	Top soil	Clay & sand	Unconsolidated gray clay and sand, loose grained with some fragmental latterite.	
4.57	12.19	7.62	Alluvium	Gravel	Unconsolidated bed of sandy gravel, sub-angular to sub-round quartz and chert shale and latterite.	
12.19	51.27	39.08	Maha Sarakham Fm.	Middle clastic	Clay	Stiff dark reddish brown with some dark gray mottling, fractures filled by gray anhydrite veins.
51.27	54.25	2.98		Middle salt (remained)	Gypsum & anhydrite	Sugary, vitreous gypsum interbedding with white gray anhydrite. Both of them are interbanded by black organic stripes in mostly horizontal layers.
54.25	83.21	28.96		Lower clastic	Clay	Stiff dark reddish brown with some dark gray mottling, fractures filled by gray anhydrite veins.
83.21	86.87	3.66		Cap anhydrite	Anhydrite	White gray, chipped and folded beds with some breccias.
86.87	182.88	96.01		Lower salt	Rock salt	Upper part is clear colorless halite with some anhydrite small-chip layer interbedding, in the lower part the halite more dirtily with smoky dark and milky white grained as well as more increasing anhydrite chips. Bedding mostly in horizontal bed. <u>Note:</u> Drilling stopped in this rock salt bed.

Table 5 Log of hole K-104 (revised and modified from Japakasetr, 1982).

Core interval (m)		Thick ness	Rock Fm./Unit	Rock type	Description
From	To	(m)			
0.00	6.10	6.10	Top soil	Sandy clay	Gray sandy clay with some light reddish brown laterite and small pieces of rock fragment, loose.
6.10	10.67	4.57	Alluvium	Sand & gravel	50:50 sand and loose gravel of quartz and rock fragments.
10.67	18.29	7.62		Clay	Soft gray to yellowish gray clay mostly.

Table 5 (Cont'd).

Core interval (m)		Thick ness (m)	Rock Fm./Unit	Rock type	Description	
From	To					
18.29	52.12	33.83	Phutok Fm.	Claystone	Hard bed rock of brick reddish brown and gray mottling claystone to siltstone with some white gypsum and anhydrite veins and veinlets.	
52.12	96.72	44.60	Maha Sarakham Fm.	Middle clastic	Clay	Stiff dark reddish brown with some small dark gray spots and layers. Some gypsum and anhydrite cut in the massive rock.
96.72	100.61	3.89		Middle salt	Cap anhydrite	Grayish white with thin banded black organic, thin lenticular and curve shape of fragments.
100.61	104.39	3.78			Rock salt	Pale brown to pale orange halite with some gray and reddish orange halite at the bottom part.
104.39	139.02	34.63		Lower clastic	Clay	Stiff dark reddish brown with some dark gray mottling, fractures filled by gray anhydrite and halite veins.
139.02	142.19	3.17		Color salt	Rock salt	Several color band of gray, orange, red and smoky dark harder halite. Some carnallite and tachyhydrite found in the lower part.
142.19	158.86	16.67		Potash zone	Tachyhydrite	75% is orange to yellow almost pure tachyhydrite, 10% is orange red carnallite and the rest is halite with a few boracites.
158.86	165.99	7.13			Carnallite	80% pink to colorless carnallite high percentage, the rest is halite with small amount of tachyhydrite.
165.99	178.46	12.47			Rock salt	Mostly colorless or clear halite in upper part and more dirty in the lower part with anhydrite chips.
178.46	178.56	0.10		Lower salt	Anhydrite	Marker bed of white gray with some black organic small bands.
178.56	218.60	40.40			Rock salt	Colorless to smoky dark and milky white grained halite, some gypsum spots found instead of anhydrite stringers or chips.
218.60	219.66	1.06	Basal anhydrite	Anhydrite	White gray, forming thin bands with abundant black carbonaceous matter at upper part, but lower is massive and boundinage structure.	
219.66	220.06	0.40	Khok Kruat Fm.	Siltstone	Grayish green, massive.	
220.06	222.81	2.75		Sandstone	Reddish brown, massive.	

Table 6 Log of hole K-105 (revised and modified from Japakasetr, 1982).

Core interval (m)		Thick ness (m)	Rock Fm./Unit	Rock type	Description	
From	To					
0.00	9.14	9.14	Top soil	Sandy clay	60 % gray clay and 40% reddish brown loose sand of siltstone fragment sand grained, sub-round to sub-angular.	
9.14	35.66	26.52	Phutok Fm.	Claystone	Hard bed rock of brick reddish brown and gray mottling claystone to siltstone.	
35.66	81.84	46.18	Maha Sarakham Fm.	Middle clastic	Clay	Stiff dark reddish brown with some dark gray mottling with some brecciated massive clay.
81.84	86.64	4.80		Middle salt (remained)	Anhydrite	Grayish white with thin banded black organic, thin lenticular and curve shape of fragments.
86.64	124.08	37.44		Lower clastic	Clay	Stiff dark reddish brown with some dark gray mottling, fractures filled by gray anhydrite and gypsum veins.
124.08	127.41	3.33		Color salt	Rock salt	Several color band of mostly clear or colorless halite.
127.41	127.94	0.53		Potash zone	Sylvite	20% is cloudy white sylvite, with 80% colorless halite with some vugs in the formation.
127.94	129.42	1.48			Rock salt	Colorless halite mostly with some spots of cloudy white sylvite.
129.42	130.15	0.73			Sylvite	30% is cloudy white and brownish red and pale orange sylvite with 80% of colorless halite with some vugs in the formation.
130.15	217.93	87.78		Lower salt	Rock salt	Mostly colorless or clear halite at upper part and more dirty at the lower part with anhydrite stringers or chips. <u>Note:</u> Drilling stopped in this rock salt bed.

Table 7 Log of hole K-106 (revised and modified from Japakasetr, 1982).

Core interval (m)		Thick ness (m)	Rock Fm./Unit	Rock type	Description	
From	To					
0.00	1.52	1.52	Top soil	Clay	Yellowish gray clay.	
1.52	18.29	16.77	Alluvium	Clay	Loose reddish brown clay.	
18.29	86.66	68.37	Phutok Fm.	Claystone	Light or brick reddish brown claystone and siltstone hard bedrock, with some fracture filled by anhydrite and gypsum veins.	
86.66	86.84	0.18	Maha Sarakham Fm.	Upper salt (remained)	Anhydrite	White gray with thin black banded carbonaceous matter, 40° dipping bed.
86.84	97.72	10.88		Middle clastic	Clay	Stiff dark reddish brown with some dark gray mottling, with anhydrite fragments near lower contact.
97.72	98.14	0.42		Middle salt (remained)	Anhydrite	White gray with thin black banded carbonaceous matter, 65° dipping bed.
98.44	110.03	11.89		Lower clastic	Clay	Stiff dark reddish brown with some dark gray mottling, with anhydrite fragments.
110.03	204.52	94.49		Lower salt	Rock salt	Mostly colorless or clear halite in upper part and more dirty in the lower part, with anhydrite stringers or chips. Upper part bedding nearly vertical but lower part bedding nearly horizontal. <u>Note:</u> Drilling stopped in this rock salt bed.

The boreholes that intersected the two salt beds with clastic clay interbedded indicate the presence of a potash zone, for example at holes K-102 and K-104. The potash zone was composed mainly of carnallite and tachyhydrite minerals. These holes not only hit the potash zone, but also the Phutok Fm. that overlaid the upper part. The Lower Salt was always located at a lower depth than was reached by the one-salt-bed holes, indicating it was a salt basin, whereas the higher elevation of the Lower Salt (mostly in the one-salt-bed holes) indicated a salt dome.

Figures 2 and 3 show the geological cross section along the one- and two-salt bed boreholes between K-103 and K-102, and between K-102 and K-101, respectively.

Although, only one sylvite bed was found in the Chalerm Phrakiat area at hole K-105, if it is compared to the geological structure, the sylvite-deposit position is at the flank of the dome, according to Hite (1982). Therefore, the flank of domes should be where sylvite mineral deposits can be found. Whether there are large or small quantities of sylvite depends on the size and shape of the dome. Figure 4 illustrates the geological cross section through K-105, K-106, K-104 and K-19.

In addition, the study indicated that the top soil overlying holes (K-101, K-103 and K-19) in areas of the one-salt bed stratum was thicker than for other holes that cut the Phutok Fm. or were drilled through two salt beds and carnallite

and the tachyhydrite of the potash zone (K-102 and K-104).

Therefore, when all the geological cross sections were compiled into a fence diagram, the geological structure was seen clearly (Figure 5).

CONCLUSION

The geology and geological structure of the potash and rock salt beds in the Maha Sarakham Fm. in Chalerm Phrakiat area, Nakhon Ratchasima province are composed of two small

salt domes or pillows and one salt basin (Figure 6). The salt domes or pillows usually have one salt bed, whereas the salt basin has two salt beds. The salt basin structure consisted mainly of carnallite and tachyhydrite mineral deposits (Sundharovat, 1977), whereas the frank of the dome or pillow tended to be composed of sylvite deposits and the uppermost part of the dome was usually only the Lower Salt bed. This information supports the salt dome theory that explains the origin of the sylvite deposits (Hite, 1979, 1982).

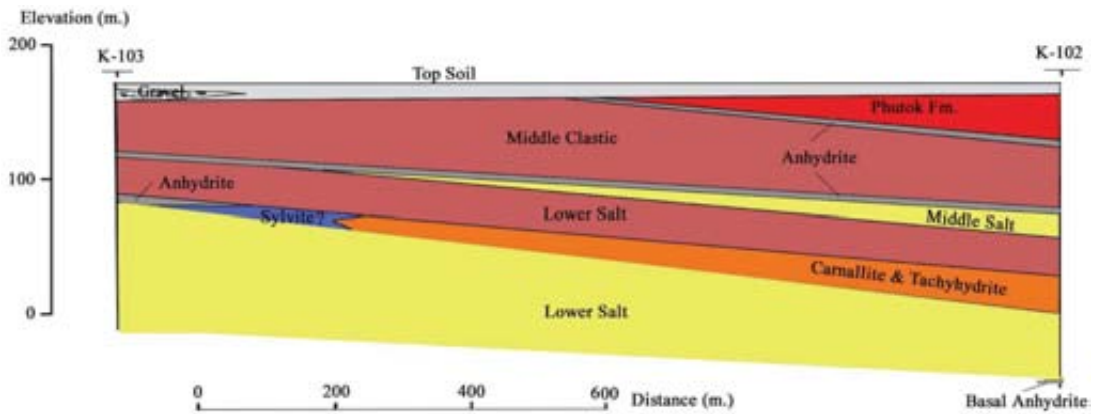


Figure 2 Geological cross section through holes K-103 and K-102 in the Chalerm Phrakiat area.

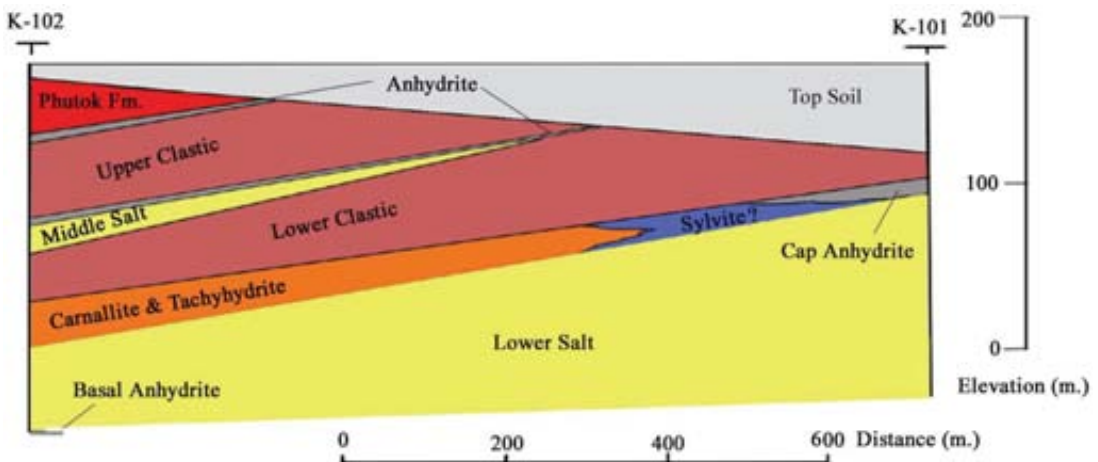


Figure 3 Geological cross section through holes K-102 and K-101 in the Chalerm Phrakiat area.

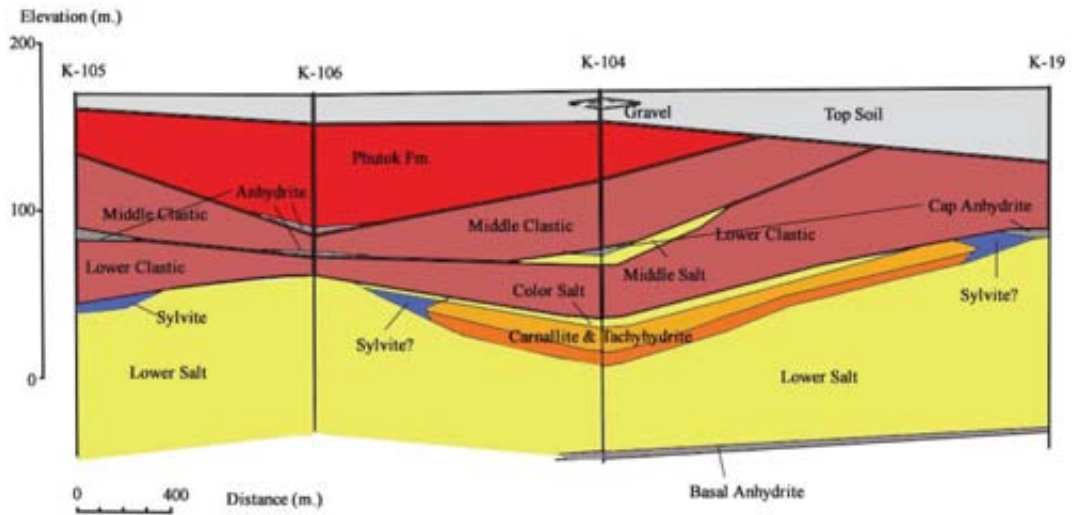


Figure 4 Geological cross section through holes K-105, K-106, K-104 and K-19 in the Chalerm Phrakiat area.

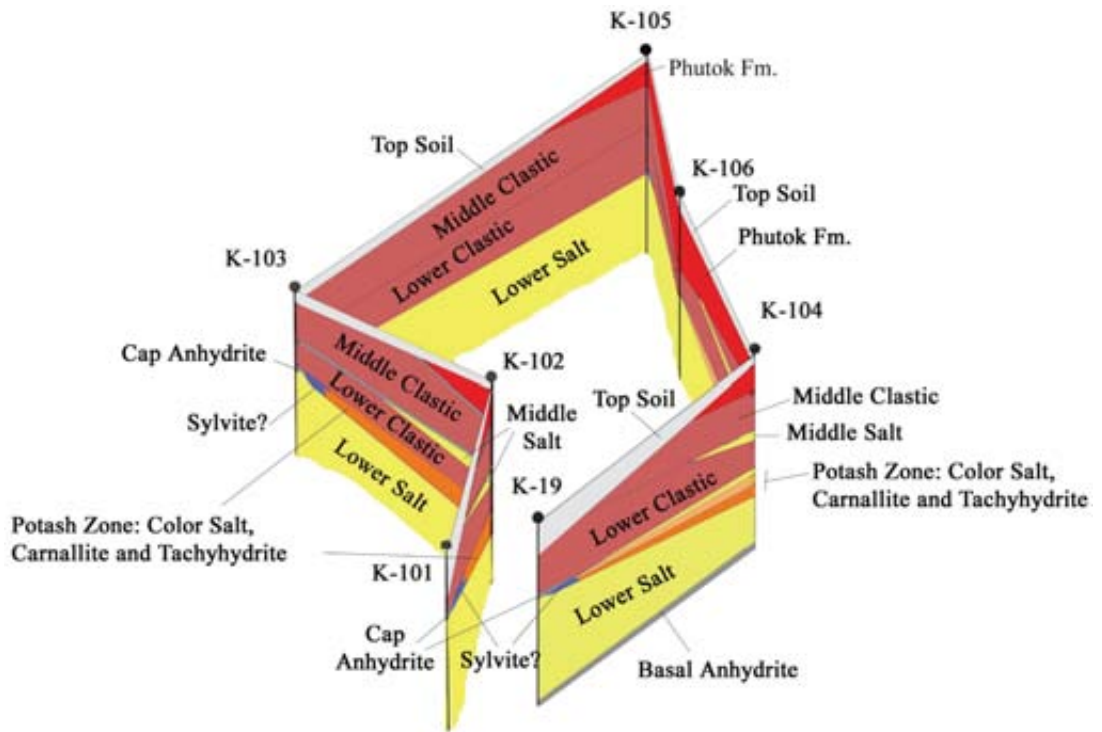


Figure 5 Fence diagram of drilling holes showing structural geology in the Chalerm Phrakiat area.

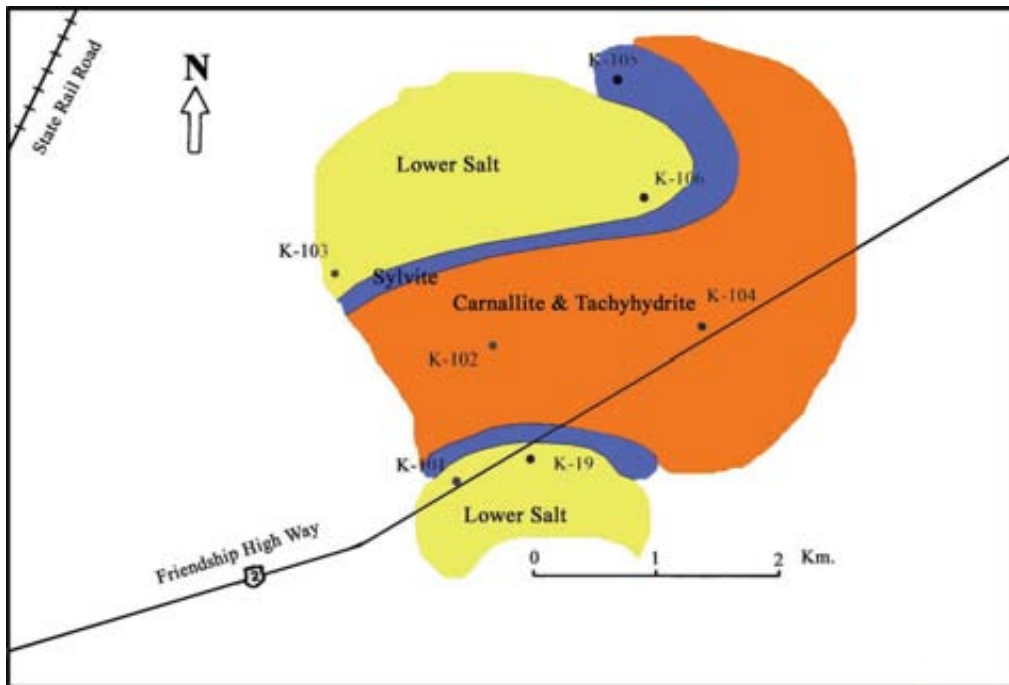


Figure 6 Facies of Lower Salt (dome), sylvite and carnallite and tachyhydrite in Chalerm Phrakiat area.

LITERATURE CITED

- Hite, R.J. and T. Japakasetr. 1979. Potash deposits of Khorat Plateau, Thailand and Laos. **Econ. Geol. J.** 74(2): 448-458.
- Hite, R.J. 1982. **Progress Report on the Potash Deposits of the Khorat Plateau, Thailand.** U.S. Dept. of the Interior, Geol. Survey. 70 pp.
- Japakasetr, T. 1980. Potash Deposits of Northeast Thailand, pp. 400-409 *In* R.P. Sheldon and E.G. Burnett (eds.). **Fertilizer Mineral Potential in Asia and the Pacific.** East-West Resources Systems Institute, East-West Center, Honolulu, Hawaii.
- Japakasetr, T. and D.R. Workman. 1981. Evaporite Deposits of Northeast Thailand, pp. 179-187. *In* **Circum-Pacific Conferences**, Hawaii.
- Japakasetr, T. 1982. **Potash and rock salt in Thailand: Appendix A.** Nonmetallic Minerals Bulletin No.2. DMR.
- Sundharovat, S. 1977. Structural Low of potash in E-sarn. **Min. Resour. Gazette** 22(7): 63-70.