PREDICTION OF FRACTURING AND DYNAMIC FAILURE OF THE ROOF IN TABULAR STOPES IN A PLATINUM MINE

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Suspected dynamic collapses of the hangingwall (roof) of tabular stopes have occurred in a platinum mine at a depth of about 250m. These stopes typically have a height of about 1,5m. They are advanced on strike (termed breast mining) and each panel has a dip span, between rock pillars, of about 28m-31m. The roof consists of anorthosite, a brittle rock with a compressive strength of about 200MPa. In the problem areas the thickness of this anorthosite is typically 7-10m (spotted and mottled anorthosite combined). It is effectively unjointed and contains no weak layering. The horizontal in situ stress in the strike direction is about 1,8 times the vertical stress at this shallow depth.

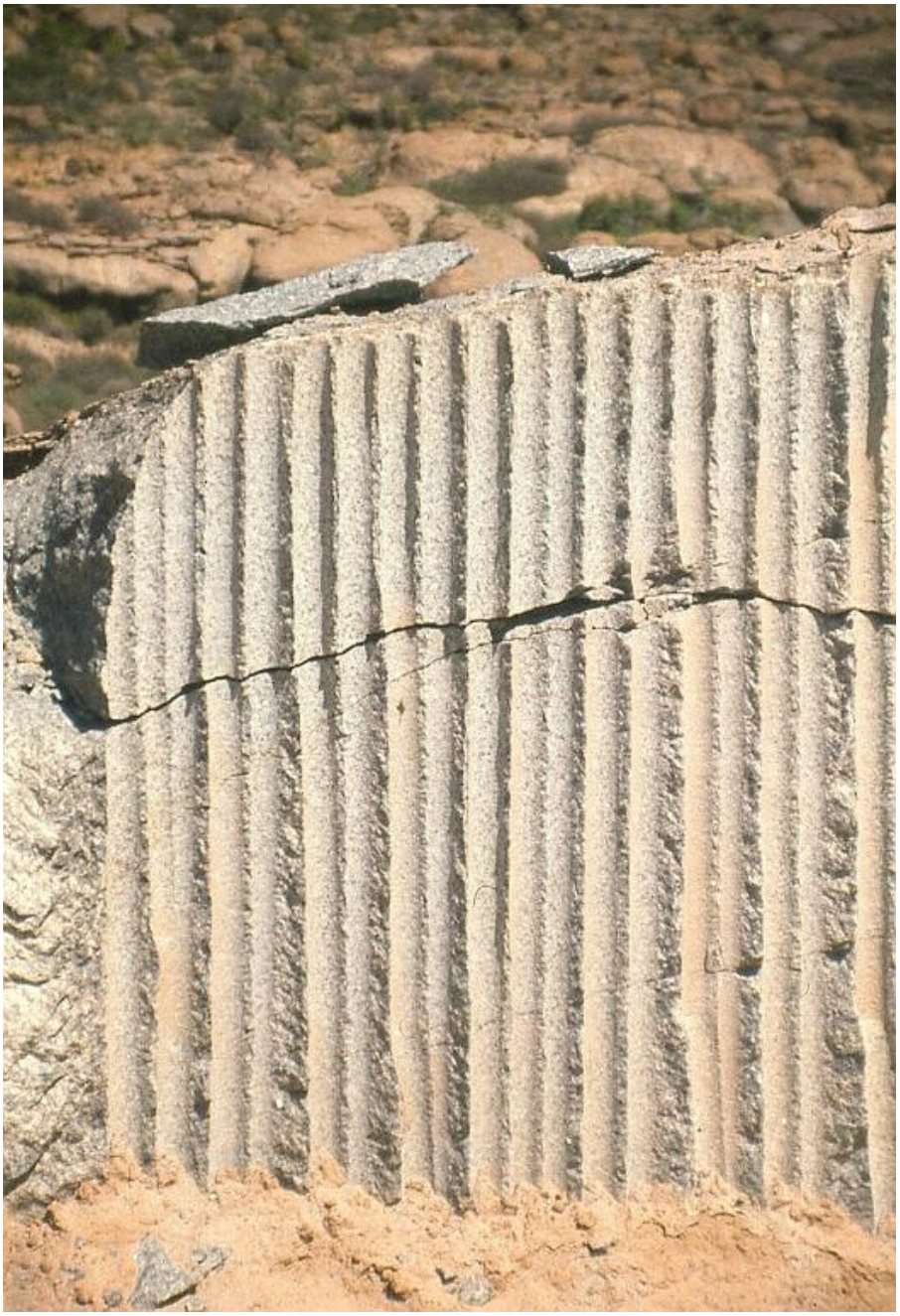
Roof falls have occurred, which indicate the effects of stress. The photograph below shows one such fall, illustrating the formation of flat fracture planes and slabs, which are frequently observed.

The development of fracturing in the stope roof has been detected using micro-seismic monitoring stations and has shown an uncommon degree of activity for such mines. It appears that fracture growth is occurring, resulting in the formation of incipient slabs. Suspected dynamic failure has occurred on several occasions, over a typical area of more than 400m^2, destroying the supports in the stopes. The observed height of the collapsed rock into the roof is about 1.5-2m. It is surmised that the perceived dynamic failures are ultimately due to violent buckling of the hangingwall "plate", but this is only opinion.

The underground slabbing is visually similar to exfoliation behaviour that can be observed on rock outcrops, as illustrated below.

A further practical example of such slabbing behavior was observed in a small granite dimension stone quarry, illustrated below.

During the drilling of the closely-spaced vertical holes, which can be clearly seen in the photograph below, a fracture developed sub-parallel to the surface. These fractures tended to occur violently and in one case it was reported that a drill was “ejected” about 3m into the air.



After the vertical face of the quarry was created, sub-vertical fractures also developed parallel to this face, which can be seen in the photograph below.

The research questions considered to be of interest are:

a) What is the mechanism and cause of the roof parallel (in the mine) and surface parallel fractures?
b) How can the thickness of the slabbing be determined?
c) What is the likely mechanism (or alternative mechanisms) involved in the dynamic failures?
d) Will it be possible for the occurrence of such failures/collapses to be predicted?

ROCK PROPERTIES

Rock Type	UCS	Ei	UTB	v	RMR	mi	mb	s	Φ	Co Intact Cohesion	UCSm	Em
	MPa	GPa	MPa							MPa	MPa	GPa
Spotted Anorthosite	200	80	14.5	.22	95	12.03	10.1	.5738	45.58	41.85	205	133
Mottled Anorthosite	200	90	13.5	.22	95	8.73	7.3	.5738	40.93	42.42	186	133
Pyroxenite	150	115	12.5	.22	80	12.01	5.9	.1084	45.59	28.92	142	56
Merensky Reef	145	110		.24	70	13.48	4.6	.0357	46.46	29.93	150	32
Merensky Reef Marikana	128	103		.24	70		0.0	.0357			0	32