Operations at the Havelock Asbestos Mine, Swaziland

The Havelock asbestos mine, situated in the north-west of Swaziland, South Africa, is owned and operated by New Amianthus Mines (Proprietary) Limited, technical services being provided by African Associated Mines (Private) Limited. Several features of the mine, which are described in the following article, are of particular interest, namely the despatch of asbestos by bi-cable aerial ropeway over twelve miles of difficult terrain to the railhead, the use of sub-level stoping, and the fact that in 1948 the original quarrying activities were discontinued and underground mining was commenced.

In January, 1930, Havelock Mine was purchased by New Amianthus Mines (Pty.) Ltd. following satisfactory disclosures made during a nine months' development option. Unfavourable market conditions prevented the immediate exploitation of the property, but in June, 1936, when it became apparent that exhaustion of ore at Amianthus mine would lead to cessation of operations there within a few years, the decision was taken to develop and equip the Havelock mine for large-scale production. The first despatch of asbestos from the mine took place in June, 1939.

INACCESSIBLE TERRAIN

This rate of progress represents a notable achievement because although the Havelock mine is only 12½ miles distant in a direct line from the nearest rail-head at Barberton in the Eastern Transvaal, a mountain range intervenes and, initially, the mine was virtually inaccessible to ordinary forms of vehicular transport. A mountain road was constructed between the mine and Pigg's Peak, a distance of 12 miles, over very difficult terrain. Thence to Hectorspruit, a point on the railway connecting Johannesburg to the port of Lourenco Marques, an existing road had to be reconditioned over its entire length of 43 miles before transport of the necessary heavy items of machinery, plant and equipment could be undertaken. The mine area is one of exceptionally high precipitation, which aggravated difficulties. Annual rainfall figures of 80 to 90 in. are not uncommon, and in February, 1939, 24.34 in. were recorded. To overcome the potential difficulty of transporting the marketable asbestos product to rail, it was decided to construct a bi-cable aerial ropeway between the mine and Barberton and this work was successfully completed by October, 1938. The ropeway has an hourly capacity of nearly ten tons and its length is 12.6 miles. Pylons on which the ropes are supported vary in height from 15 ft. to 165 ft. Subsequent to the outbreak of the war in 1939 a 28-mile all-weather road was constructed connecting the mine to Barberton, a difficult feat of highway engineering.

THE GEOLOGICAL SYSTEM

The fibre-bearing serpentine ore is apple green in colour. The body of ore is enclosed in rocks of the Moodies Series of the Swaziland System. These are light-coloured, fine-grained argillaceous and arenaceous sediments in which occur zones of banded and sometimes ferruginous cherts. The cherts outcrop prominently in numerous ridges in a deeply weathered area.

The formation as a whole dips south at an angle of approximately 50 deg. from the horizontal. Conformably with this the ore body has a similar dip and in direction of strike it extends 4,500 ft. east and west with a true thickness of 150 ft. The hanging wall and footwall are not sharply defined and resolve into economic limits. In the footwall is a sheared almost black barren serpentine. Within the green massive serpentine ore body seams of chrysotile occur in the nature of stockworks.

The length of individual asbestos fibres varies from less than ¼ in. up to 1½ in. and 2 in. The serpentine of the hanging wall is very dark green and is less sheared than that of the footwall. Not far distant from the ore body hanging wall is a granite-like dyke striking in a parallel direction and, as far as observations go, following the ore body in dip. Deeper into the footwall are chert layers between which and the footwall serpentine is a very disturbed zone over a width of from 60 to 100 ft., which is assumed to be a strike fault.

INCLINE SHAFT MINING

The mine has been developed from an inclined shaft dipping south of 40 deg. There are two hoisting compartments in which ore is hauled in 5-ton skips, and a pipe and ladderway compartment. The depth of shaft on incline is 1,280 ft. from the collar, the bottom being 25 ft. below fifth level.

Quarrying, which provided the bulk of the mill ore initially, was discontinued in 1948, giving way to underground mining operations. The ore body has been developed, on third level and above, to its extreme eastern and western limits and stoping is retreating from these extremities towards the main shaft pillar. At convenient intervals on strike, service and rock raises are devoloped well in the footwall.

The service raises are equipped with a ladderway, ventilation, compressed air and water pipes and a skip. They constitute the travelling ways to sub-levels and provide means of handling equipment. The rock raises are used during the sub-level development period of the stoping block or blocks in their vicinity.

SUB-LEVEL STOPING

Three methods of sub-level stoping have been tried the first of which, of strike retreat, has been discontinued. In it a slot is cut across the ore body from footwall to hanging wall and parallel slices are taken across the body retreating along the strike.

The other two methods are similar to each other, in one the slot is cut in the hanging wall and extends for the full length, on strike, of the block to be stoped, slices are taken by retreating towards the footwall; in the other method the direction of retreat is towards the hanging wall from a slot cut along the footwall.

Generally speaking, the western portion of the ore body is more fractured or sheared than the eastern and does not stand so well. This circumstance has led to the adoption, on the eastern side, of the hanging wall to footwall retreat method and on the western side, the footwall to hanging wall retreat. In the latter blocks, once the cave has been initiated from the original slot, it is seldom necessary to blast rings on the sub-levels other than those necessary to extend the footwall slot. On the eastern side the stronger standing ground entails blasting of rings on all sub-levels.

The sub-levels are developed at 30 ft. vertical intervals.

The lowest sub-level, that which is immediately above the main tramming level, is the grizzley sub-level where the broken ore is drawn from the stope through draw-points on to grizzleys constructed over ore passes from which the ore is loaded into trucks on the tramming level.

Dimensions of a typical stoping block on the eastern side between first and third levels are 400 ft. on strike and a vertical interval of 217 ft.; six sub-levels being spaced at 31 ft. intervals. On each sub-level footwall and hanging wall drives are developed which are connected by crosscuts spaced at 60 ft. intervals. The footwall drive is located approximately 30 ft. in the footwall of the ore body and is so placed to permit the footwall of the stope to be steepened if required to draw off ore which might otherwise be lost. The hanging wall drive is placed within the ore body about 50 ft. from the hanging wall limit of ore. Ore passes from the grizzley level are spaced at 60 ft. intervals in the crosscuts and each receives ore from two drawpoints (four drawpoints in the earlier practice).

ROCK BREAKING

Blast holes are drilled from the hanging wall drive to the approximate hanging wall limit of ore and, in direction, from the horizontal to the vertical, while in the crosscuts the so-called " ring drilling " east and west is also from the horizontal to the vertical up to the next sub-level above. The ring drilling from each crosscut covers an area 30 ft. on either side of the crosscut to a height of 30 ft.

Glass models are prepared for each stope block, each sub-level being correctly positioned, and all drives and crosscuts are depicted. Each ring of holes drilled is accurately shown. Constant reference to the glass models as stoping progresses is necessary to exercise the necessary control and obviate undercutting upper sub-levels.

Rotary drills are employed in ring drilling. They are fitted with blast hole feed end coupling adapters to take 24 in. EX extension rods and couplings. Tungsten carbide crowns are used in conjunction with a crown adapter. Drilling rates are rapid, up to 24 in. per min. and a sequence of operations has been evolved to ensure maximum drilling time during the shift. Under favourable conditions a crew can drill up to 460 ft. of 1⅝ in. or 1¾ in. hole per 8-hr. shift. Crown life averages 4,000 ft. A specially designed brass protractor is used to lay out the drill hole pattern accurately and ensure the toe burden does not exceed 6 ft.

Blasting with millisecond electric detonators had to be abandoned in favour of cordtex-fuse blasting because of contamination of the bagged graded asbestos with copper wires.

TRAMMING OPERATIONS

On third level, ventilation drives are developed between the hanging wall, mid and footwall tramming drives and from them raises, about 3 ft. square in section, are put up to the grizzley sub-levels to hole between two grizzley points. These raises can be brought into operation at will by means of adjustable flaps to ensure the rapid removal of fumes from any drawpoint area following secondary blasting.

Transport of ore on the main tramming levels has undergone a process of evolution from hand tramming in 16 cu. ft. U-V side-tipping cars, to endless rope haulage and belt conveyor systems. Granby type cars with storage battery electric locomotives are under consideration for future ore transport installations. The whole of the mine from third level and above is drained by means of a 3,496 ft. drainage adit.

ORE TREATMENT

Milling practice has undergone continual modification to achieve the following objectives:

(a) labour saving;
(b) improved extraction of chrysotile from mill ore;
(c) improved bagged fibre quality.

An initial sizing segregation takes place for the purpose of drying the wet ore below 2½ in. ring and crushing the coarse ore to this limit. Drying takes place in tower dryers down which the material showers is a direction opposed to the hot flue gases. Depending upon the degree of moisture in the mill feed, drying can be done in two tower dryers in parallel or in series. The moisture content of the dried ore is subject to control.

The customary method is employed of separation of fibre released in each stage of crushing by means of vacuum nozzles suitably adjusted in respect of air pressure and distance from the prepared crushed ore system.

Crushing is performed in stages, initial reduction of coarse elements taking place in jaw crushers followed in succession by cone crushers and two types of impact mill. In one of these the hammers are mounted on a horizontally disposed shaft, and in the second, the shaft is vertical.

Screening apparatus in use in conjunction with stage crushing and air separation comprises trommels and flat screens to which an appropriate oscillatory motion has been imparted. The screening medium is steel wire cloth with square mesh apertures.

Two fan systems are employed, one for the separation of asbestos from rock and the other to prevent contamination of the mill atmosphere with dust. Both fan systems discharge into filters of the fabric tube variety which deposit dust and obviate pollution of the atmosphere in the vicinity of the mills.

Extensive use is made within the mills of belt conveyors, including final discharge of the waste discard to dump and a substantial saving in labour is thereby effected. Bagging of the graded fibres is also done mechanically. Four standard fibre grades are prepared, bagged in hessian bags of 125 lb. net weight each under the bag marks HVL/24, HVL/3, HVL/4 and HVL/5.

Over 400,000 tons of asbestos have been produced since commencement of operations in 1939, resulting from the mining of 10,000,000 tons of ore and removal of 3,500,000 tons of overburden in the quarrying stages of exploitation.

POWER SUPPLY

In June, 1953, a new power station was commissioned replacing the original diesel-electric power generating installation. The new plant comprises a 4,000 kW. turbo-alternator with two water tube boilers with mechanical stokers, superheaters, feed heaters, surface condensing plant and economizers. The turbine is supplied with steam at a pressure of 400 lb. p.s.i. and a temperature of 760 deg. F. Each boiler is capable of evaporating 26,000 lb. of water per hr. under normal working conditions.

To maintain power supply during routine inspection and maintenance periods and for general emergency purposes a six-cylinder diesel engine with 600 kW. alternator is provided.

Accommodation has been provided for 154 European employees and 2,350 African employees and their families and health services are in the care of a full-time Medical Officer.