MINING AND PROCESSING PROBLEMS AT THE BAREGA BARITE MINE (SARDINIA)

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ABSTRACT

The barite district of South-West Sardinia is characterized by the presence of a number of small orebodies scattered over a large area. Because of the karstic genesis, their size, shape and composition are extremely variable thus posing the problem of suitably planning exploration and mining operations in order that the ore may be profitably beneficiated under varying constraints. At the Barega mine different mining methods are implemented according to the characteristics of the orebody and host rocks using simple easily movable equipment. Besides some residual opencast operations, the vein-type mineralizations are generally mined by sublevel stoping or sublevel caving, whereas the more irregular funnel-type masses are exploited by shrinkage stoping. Profitability of the operations, which is *presently hampered to a certain extent by the fall in market price of oil-drilling barytes, is subject to the feasibilty of applying tailored low-cost mining methods to each orebody using common equipment as well* as *to setting up a versatile beneficiation process suitable for each kind of ore, from easily washable to finely intergrown. After* a *brief description of the geological features of the Barega mine, the paper illustrates the mining methods currently applied giving some significant data on field operations and the technical and economic reasons underlying the solutions adopted. Loading and hauling problems are also outlined. Processing by jigging and flotation is then illustrated in detail. Finally conclusions are drawn concerning the flexibility of the productive structure in order to accomodate any change in the variables, either internal or external to the system such as the market demand and price for the* various *utilizations (chemicals, drilling muds, filling agents).*

ÖZET

Güney batı Sardunya'da barit havzasının özelliği, çok sayıdaki küçük cevher yataklarının geniş bir alana yayılmış olmasıdır. Karstik yapılaşmadan dolayı bu yatakların şekli, kompozisyonu ve tane büyüklükleri çok değişiktir. Bu durum-, *cevherin değişen koşullarda ekonomik olarak çıkarılması için uygun planlama, hazırlık ve işletme sorunlarını ortaya çıkarmaktadır. Barega madeninde basit, kolay hareket edebilen teçhizat kullanılarak, cevherin ve yan taşların özelliklerine göre farklı madencilik yöntemleri uygulanmaktadır. Birkaç açık işletmenin yanında damar tipi mineralleşmelerde uygulanan yöntem genellikle ara kesmeli göçertme (sublevel stoping) veya ambarlı göçertmedir (Shrinkage stoping). Daha düzensiz olan filon tipi yataklarda ambarlı göçertme kullanılmaktadır. Petrol sondajında kullanılan baritlerin fiyatının bugünlerde düşük olmasının da bir dereceye kadar etkilediği faaliyetlerin ekonomikliği ile ilgili esas konu klasik teçhizatın kullanılması ile her cevher için düşük maliyetli bir yöntemin uygulanabilmesi ve bunun yanında her cins cevhere uygun bir lavuarın kurulmasıdır. Bu bildiride Barega madeninin jeolojik yapısından* feısaca *bahsedilmekte, halen uygulanan madencilik yöntemleri ve bunların temelindeki teknik ve ekonomik nedenler açıklanmaktadır. Yükleme ve nakliye sorunları hakkında bilgi verilmekte, jig ve flotasyon yöntemleri detaylı olarak anlatılmaktadır. Son olarak piyasa talebi, çeşitli maddelerin (kimyasal maddeler, sondaj çamuru, dolgun maddesi) fiyatları gibi iç ve dış değişkenleri sisteme uydurmak için üretim yapısının esnekliği ile ilgili sonuçlar verilmektedir.*

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1 GEOLOGIC OUTLINE

Concessions of the Barega mine cover almost completely the outcropping formations tpyical of Cambrian series in Sardinia, consisting of sandstones, limestones and shales, in order of deposition.

The series is corrugated by subsequent orogenesis processes and partially eroded so that tougher limestone mountains emerge well above the flatter countryside of weaker shales and sandstones.

Barite orebodies are hosted in the carbonatic rocks; three main groups can be distinguished, according to geometric features and composition:

— Vein-type orebodies resulting from secondary deposition of barite and accompanying gangues into opened faults or fractures. Barite is often finely intergrown with gangue minerals, especially quartz, and this may render very difficult the processing problem especially as far as concentrate quality is concerned.

— Column-shaped masses embedded in karstic cavities with variable size, shape and ore composition features. Barite is generally well crystallized wit hvery favouralle intergrowth characteristics so that the run-of-mine is easily amenable to processing;

— Flat lenses of alluvial metarial, sometimes covered by quartzites, where sharp edged barite pebbles and fragments are intermingled with a clayey soil, altough of a lower grade, ore can be economically processed after desliming.

The quality of ore reverves has deteriorated substantially over the last few years owing to the fact that in the past beneficiation was focused mainly on richer ores. Presently the proportion of difficult-to-treat ores accounts for about 60 % of the total, thus posing additional processing problems which need to be carefully solved to obtain marketable products with economically acceptable recoveries.

The future of the mine depends on the possibility of discovering new mineralizations outside the boundaries of the traditional area to which exploitation was hitherto confined.

Opencast works in the outcropping part of the mam orebody are shown in Figure 1.

2. GENERAL FEATURES OF THE MINE

The present mining organization was determined by the features of the available ore reserves, only a small part of which can be mined opencast. Moreover, single orebodies are very variable in size, from a few thousand up to some hundred thousand tonnes of recoverable ore.

As far as rock mechanics is concerned, host rocks are generally strong and competent so that no roof support is normally required in sublevel driftings or haulage ways.

Only occasionally steel frames or concrete vaulting must be used for crossing faults or localized weakness zones, according to needs However there are instances where the hanging wall consists of a thick layer of clayey material which after exposure to air easily caves into the emptied stope creating problems of ore pollution if not carefully controlled

In the light of the above a very flexible organization is required to face the ever changing mining conditions

The major policy at the mine is to adopt simple and easily movable equipment, adapted to a variety of working conditions so as to allow in most cases both easy maintenance and ready availability For this purpose leg-mounted light drifters are used for development works whereas heavier tools like wagon-drills are employed in production drilling

Face mucking of blasted metarial is accomplished with crawler loaders into ore raises More recently LHD diesel powered vehicles have also been introduced in deeper or remote stops Trucks ar employed for hoisting and haulage up to the processing plant

All such equipment can be used in either opencast or underground operations, thus allowing very high utilization coefficients to be attained Similar guide-lines are followed in ore processing, currently the plant can handle materials of diverse characteristics from lean earths to richer ores either well liberated at coarser sizes or finely intergrown with the gangue, in fact machine settings and even the flowsheet can be promptly adjusted in order to meet optimum process outcome On average about 650 tonnes of run-of mine are produced daily, this figure can be increased up to 800 in periods of peak market demand

The processing plant has a maximum throughput capacity of 1,200 tpd which can be matched by resorting to ore supplied by external producers In this way the plant was conveived as a custom mill for beneficiating ores from the small mineral occurrences in neighbouring zones

The labour force of the mine counts some 850 workers including those employed in the processing plant and general services 40 of whom work underground plus supervisors and management making a total of about 100 Yearly concentrate production presently amounts to about 31 000 tonnes owing to the slump in demand for oil well drillings however a peak of 45 000 t has been reached in latter years on account of the very favourable market situation

3. UNDERGROUND MINING

3.1. Structure of the Mine

An underground structure suitable for trackless mining was designed about 20 years ago, when the outcropping parts of the main orebodies were near depletion rendering opencast mining no longer feasible.

In the transition phase the same kind of equipment was maintained and adapted to the new situtation. Nowadays the technical solutions are basically the same with the improvements suggested by experience gained or proposed by technological progress.

The access ways consist in horizontal crosscuts dug from the hillside at lower levels; as workings deepen it is necassary to drive inclined galleries with a 15-20 m^2 cross section, for faulage, service and ventilation. A main incline serves a group of orebodies which account for about 60 % of the available reverves. Orebodies are connected to the incline through short slants at each sublevel; development drift intercommunicating by means of raises or steep ramps are then excavated into the orebody.

Generally one every four sublevels is used as the haulage way allowing access to 15 tonnes payload trucks.

On account of the extreme variability of both the characteristics of the orebodies and the restrictions to mining, many methods are being used at the Barega mine:

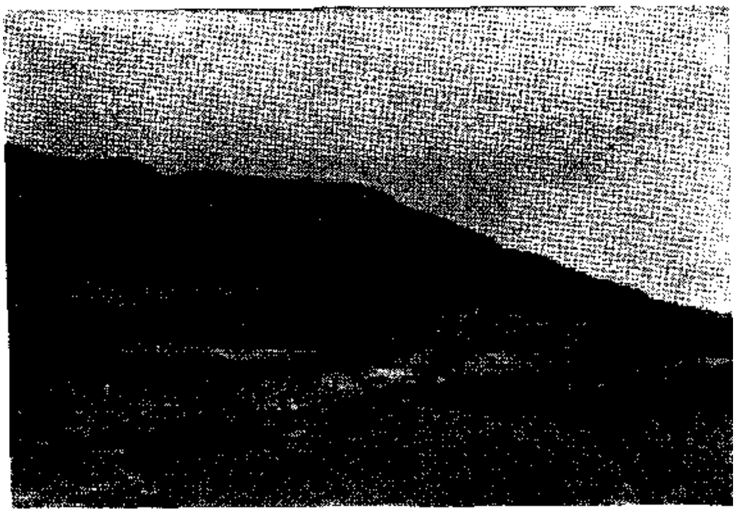

Figure 1 — Out cropping parts of the opencast-mined "Gianni" Vein at the Barega barite mine

- Shrinkage stopmg is common practice in small and very irregular veins or for side prominences of bigger orebodies;
- Sublevel stopmg is widely applied wherever ore and host rocks are competent;
- Sublevel caving must be adopted in presence of weak hanging wall and in particular when clay layers are too close to the orebody,
- Methods with abandoned pilars are preferred when lean zones not worth beneficiatmg are included inside the orebody;
- Funnel-shaped open pit mining is of course resorted to for outcropping or close-to-surface mineralizations

3.2. Development and Sublevel Drifting

As already mentoned, main inclines and haulage ways are opend with a minimum cross section of 15 m^3 in order to allow the passage of trucks and the manoeuvering of loaders. Even in this case light equipment is used for drilling, since fast advance rates are not normally needed; if this was the case, a twing-boom jumbo shared with another mine of the same Company is occasionally used for accelerating excavation. Sublevel drifts are dug in a similar way but require a smaller cross area.

In both cases drilling patterns with parallel holes are generally adopted; for sublevel drifting the following technical data can be given.

- average advance rate- 1 50 m per blast
- volume of blasted rock: 14.40 m^3 per blast
- manpower productivity- 6.40 m^3 per man-shift
- explosive consumption: 1.53 kg/m^3
- Blasthole efficiency 0.30 m^3/m
- mucking rate of crawler loader- 6.40 m^3/h

Correspondingly, unit costs of drifting split into the main components are as follows:

— manpower	180,000 Lit/m *
— explosive	*60,000* "
— compressed air (including drilling wear)	78,000 "
— spare parts	30,000 "
— loader (including operator)	*60,000* "
— mine services	88,000 "
— ocerhead expenses	50,000 "
TOTAL	546,000 "

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* Costs, given m Italian lire, are up-dated to 1986

3.3. Details of Sublevel Stoping

The method is applied in either vein- or column-shaped orebodies, wherever rock strength assures sufficient stability of emptied stopes thus avoiding any risk of danger to personnel and equipment while minimizing the possibility of ore pollution.

Sublevel drifting sceme is adapted according to the particular case; vertical spacing may vary between 10 and 20 m, the shorter distance being maintained for very irregular mineralizations, whereas the longre is economically more convenient for veins with net and almost plane contacts with the embedding rocks.

In this latter case optimum sublevel spacing can ve calculated by resorting to Operations Research and mathematical simulation. Optimum spacing, found by computer processing, is a compromise between the need to limit the incidence of drifting on mining cost and that of producing a run-of-mine with the highest possible BaS04 grade.

Production drilling is done with 60 kg compressed air drifters mounted on wagon-drills according to parallel hole patterns drilled upwards from the lower sublevel. Bench face is inclined outwards at an angle of about 70 degress.

A very interesting modification of traditional patterns has been successfully experimented for the highest benches in order to further limit ore pollution of long hole blasting. By this new approach half bench is drilled upwards from the lower sublevel and the second half downwards from the upper sublevel so that any irregularities of orebody boundaries can be better followed. The result is a slight increase in ore recovery, in addition to a controlled blasting of waste rock.

Blastholes are loaded with ANFO explosives primed with gelatin cartridges at both column ends and connected with detonating fuse. Firing is by shortdelayed electric caps. Generally two rows or fans are blasted simultaneously.

The number of holes per fan as well as the relevant blast parameters may vary for each case, according to the geometric features of the orebody.

As an example data relative to a short bench mining of a 1,000 to 1,800 m^2 column-shaped mass are given below:

— horizontal sublevel spacing: 7.5 m
— bench net height: 8 0m
— blast burden: 3.0 m
— average hole spacing: 0.9 m
— overall hole length per fan: 55 m
— number of holes per fan: 8
— average hole length: 6.9 m
— hole diameter- 51 mm

— explosive consumption per fan:
ANFO: 124 kg, gelatine: 26 kg
— manpower productivity (drilling -f blasting): 58 t per man-shift
— blasthole efficiency: 4.2 t/m
— explosive consumption: 0.260 kg/t
— mucking rate of crawler loader: 55 t/h

Correspondingly, unit production costs referred to one tonne of ore blasted, mucked and dumped into the ore raise are as follows:

— manpower	2,065	Lit/t'
— explosive	900	"
— compressed air (including drilling wear)	625	"
— spare parts	95	"
— crawler loader (including operator)	695	"
— mine services	1,140	"
TOTAL	5,520	"

Taking into account the proportions of ore obtained in drifting (15 %) and production blasting (85 %), the resulting cost of one tonne of run-of-mine including the incidence of drifting is 6,550 Lit/t.

Benches are blasted individually and the resulting ore is mucked at each sublevel. This allows a better control of ore quality and helps to smooth grade variations of the processing plant feed.

Somewhat different are the technical data and unit costs for sublevel stoping applied to narrow veins. Compared to the previous case two main differences can be pointed out; sublevel spacing is increased up to 18 m, allowed by a more regular orebody geometry and mucking is done with compressed air overshot loaders for reasons of salubrity of working environment and manoeuvrability restrictions. Since drift width is almost equal to the average vein thicknes, fans are replaced by rows of parallel drillholes loaded with gelatine explosive, which give a better productivity.

The following tecnical data can be given-.

— bench net height: 15.0 m
— blast burden (horizontal distance of rows): 2.0 m
— ore blasted per row: 230 t
— average hole spacing: 0.6 m
— overall hole length per row: 40 m
— number of holes per row- 5
— hole diameter: 51 mm
— explosive consumption per row: 50 kg

Costs given in Italian Lire, up-dated to 1986; 1000 Italian Lire correspond to 0.71 US$ (conversion rate of december 1986)

— manpower productivity (drilling t- blasting): 77 t per man-shift
— blasthole efficiency: 5.75 t/m
— specific explosive consumption: 0.217 kg/t
— mucking rate of the overshot loader
(average haul distance 50 m): 25 t/h

The following unit costs are obtained:

— manpower	3,015	Lit/t
— explosive	920	"
— compressed air (including drilling wear)	460	"
— spare parts	100	"
— mucking (including operator)	1,430	"
— mine services	1,150	
TOTAL	7,075	"

Allowing for the cost incidence of drifting too, which accounts for about 8 % of the run-of-mine produced in the stope, the overall unit cost rises to a total of 8,510 Lit/t Despite the very low level of mechanization, cost figures can be considered quite satisfactory.

Where vein thickness is large enough say above 5-6 m, and the orebody sufficiently regular in shape, mucking at each sublevel is eliminated; blasted ore falls down into funnel-shaped bins prepared in advence by properly enlarging a series of short raises driven every 12 m from the base level. Bins are about 12 m high and have a top cross area of 60 m^2

In this case manpower stope productivity is expected to attain 100 t pr man-shift wirth considerable reduction in operating cost.

A bin under development is shown in Figure 2

Figure 2 — Bin excavation at the base of a stope mined with sublerel stoping method at the Barega Barite mine

3.3. Sublevel Caving Method

This method is applied wherever the orebody is in close contact with weak rocks, in these cases caving must be carefully controlled if ore pollution is to be avoided

Development drifting is similar to that of sublevel stoping: only one gallery, centrally positioned between the orebody walls where vein thickness is less than 5-6 m, two or more galleries, spaced on average 7.5 m, where vein thickness exceeds 7-8 m. Benches are blasted one at a time. As an example, it seems interesting to report the significant data obtained during the exploitation of a thick vein, now almost depleted.

This lens-shaped orebody has a maximum thickness of 25-30 m, in its central part, an overall depth of 200 m fro mthe outcrops down to the lowest level and a length of about 300 m. The last two sublevels are presently being mined.

Drilling pattern varies according to orebody thickness. Drilling and mucking are done with the same kind of equipment as that used in sublevel stoping. However in the.deepest sublevels the crowler loader has been replaced by a Load-Haul-Dump Diesel powered scooptram provided with 1.75 m^3 bucket, capable of economically covering longer mucking distances, up to200 m. By this device truck loading point couild be moved farther away from the face, thus minimizing air pollution drawbacks.

The main technical problem encountered with sublevel caving is that of assuring an acceptable separation between ore and waste rock during blasting and loading operations.

The solution adopted is the result of a careful experimental study of bench forward inclination and blast design. It has been found that optimum conditions are met if an angle of 65 degrees is maintained. In this way caved material is in contact with the ore in place over the entire bench front area so that blasting produces a more prominent compaction affect favoring ore sliding. Moreover flyrock is restricted and therefore ore recovery somewhat improved.

The technical and economic data of major significance, referred to the average orebody thickness of 5.9 m, are reported below:

— bench net height: 7 m
— bench face inclination: 65 degrees
— ore mined per blast: 330 t
— blast burden
(horizontal distance between rows): 2.5 m
— average hole spacing 1.0 m
— overall hole length per row: 55 m
— hole length: 8 0m

— hole diameter: 51 mm
— explosive consumption per row
ANFO. 69 kg
gelatine: 6 kg
— gelatine consumption for secondary blasting: 5 kg
— manpower productivity (drilling + blasting). 82.5 t per man-shift
— blasthole efficiency: 6.0 t/m
— specific explosive consumption: 0.240 kg/t
— mucking rate: 33 t/h

Unit production costs (including mucking to the truck loading point) can be split as follows:

— manpower (drilling + blasting)	1,820	Lit/t
— explosives	520	"
— compressed air (including drilling wear)	440	"
— spare parts	90	"
— loader (including conductor)	1,290	"
— mine services	1,320	"
TOTAL	5,480	"

The addition of drifting costs gives an overall figure of 6,320 Lit/t A detail of the drawpoint of sublevel caving is shown in Figure 3.

Figure 3 — Drawpoints of blasted ore in a stope exploited with sublevel caving method at the Barega barite mine

4. HAULAGE PROBLEMS

Owing to the extensive geographic distribution and variability of the orebodies, loading and haulage problems represent a critical aspect of the whole organization.

The object is to assure regular feeding to the processing plant as far as both overall daily rate and ore grade are concerned. This is a very stringent requirement owing to the fact that large stockpiles cannot be accumulated for technical and economic reasons. The need for a satisfactory utilization and esay maintenance of the fleet of vehicle, calls for equipment standardization. Actually this is the solution adopted from the start.

Crawler loaders are widely used under different conditions because of their inherent, flexibility; they can oprate in very narrow areas and in adverse ground conditions like muddy soil; moreover they are able to climb very steep ramps.

Trucks with 15 tonnes payload are used for both surface and underground haulage. However this solution is no longer optimal for hoisting along the 14 % incline from deepest stopes. In fact transportation rate has declined considerably in this case owing to lower practical load and travel velocity.

Computer simulation applied to the whole transportation system of the mine revealed that 20 tonnes payload dumpers wou^.d be better suited with the new situation characterized by a substantial increase of comuag from deepest stopes.

5. ORE BENEFIC1ATION

5 1. The **Processing Plant**

The flowsheet of the processing plant is shown in Figure 4. It consists of a multi-stage crushing section, the gravity separation plant and a flotation line.

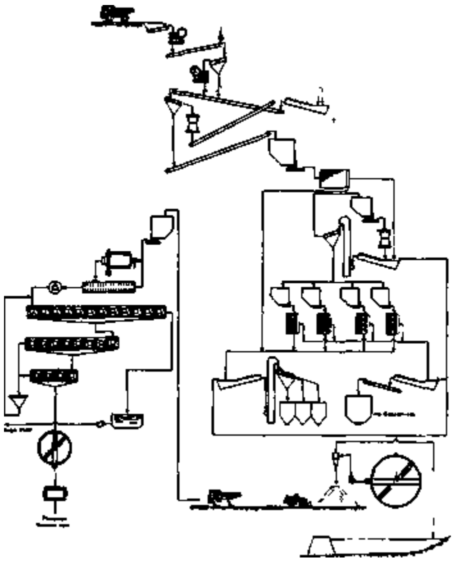

Figure 4 — The flowsheet of the processing plant

The ore is drawn from the stocpiles by means of a wheel loader and fed via apron feeder to the primary jaw crucher where it is reduced to below about 200 mm; the oversize of the 70 mm screening is then further ground in the secondary jaw crusher. Where necessary the ore is passed through a logwasher for desliming; otherwise it is, sent direct to a third Hydrocone crusher in closed circuit with a 20 mm screen, where final size reduction takes place.

The granulated product is stored in a bin of 1,200 tonnes capacity heading the gravity section.

The upgrading process consists of two jigging stages in series. In the first stage, the entire feed range (—20 mm) is treated in two parallel oscillating frame jigs, each having a throughput capacity of 45 t/h.

Coarse waste is screened for recovering classified aggregates for civil engineering applications (road construction or concrete bricks); the finest (—3 mm) class may still contain residual barite values worth recovering by flotation, according to market price.

Preconcenträte, dewatered in a screw classifier, is completely ground to below 8 mm with a short-head Symons cone in closed circuit with a 8 mm vibrating screen; dewatenng fines are thickened and sent to flotation.

The final cleaning stage is carried out in four fixed frame jigs, each having a capacity of 7-8 t/h, both final concentrate and middlings are dewatered in separate screw classifiers, overflowing fines still contain a considerable proportion of bante and are thus amenable to flotation after settling in a Dorr thickener Coarse middlings are treated in the same way as coarse preconcentration waste

The overall view of the processing plant is shown in Figure 5

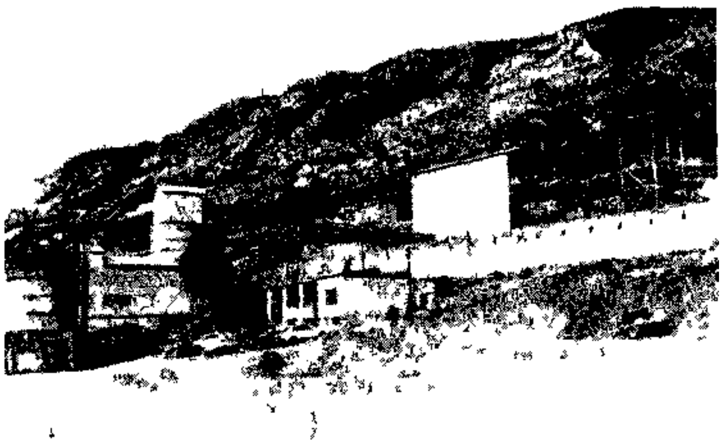

Figure 5 — Overall view of the crushing and jigging sections at the barega mine

Prom the above it emerges that flotation feed consists of the thickened pulp from the Dorr settling vessel with a possible addition of the C—3 mm) class of coarse waste screening. The feed material is ground to minus 40.4 mm in a ball mill controlled by rake classifier; the resulting pulp, after conditioning with about 1 kg/t of Na-silicate at a pH around 10, is subjected to roughing with the addition of slightly more than 1 kg/t of Na-cethylsulphate; froths are recleaned twice to obtain a filter cake assaying about 95 % BaSCX

5.2. Ore Characteristics and Technical Result

All the ores mined from the various orebodies are beneficiated following the flowsheet outlined above. However the ensuing technical and economic results are quite different depending on the origin, i. e. the BaSOi grade of the ore and, above all, the intergrowth characteristics. For this purpose, the run-of-mine can be classified into two main classes:

A — Crude ores whose components can be liberated at a relatively coarse size (8-10 mm), and are thus easily washable with gravity methods;

B — Crude ores characterized by a relatively fine dissemination of silica, barely separable at the granulation size; its gravity beneficiation poses some problems due to the poor concentrate quality as well as the considerable losses in the waste.

On the other hand flotation yields similar results for both ores, barite being sufficiently liberated at the grinding size (—0.4 mm). The only difference is a higher SİO2 content of concentrate from ore B but this does not represent a drawback since concentrates are blended before delivery to the same customer.

High quality (up to 95-96 % BaSOJ concentrates can be obtained from ore A, whereas those obtainable from ore B are considerably poorer and fall short of drilling mud specifications (4.20 specific gravity, corresponding to 89-90 % BaSCW. For this latter ore barite recovery rapidly deteriorates when concentrate grade is to be forced beyond 86 %. Moreover it should be underlined that, although the barite values lost in the jigging phase are partially recovered by subsequent flotation, overall benef.iciation economics is worse than for ore A, since flotation is considerably more expensive.

In brief, ore availability and process flowsheet enable the following products to be obtained:

- granular high grade barytes assaying up to 94-96 % BaSO, with low silica content;

- granular barytes of poorer quality (less than 87-89 % BaSCu), contaminated with a relatively high proportion of silica (exceeding 5 %);
- high grade flotation concentrate (above 95 % BaSCu);
- classified aggregates for civil engineering applications.

5.3. Flowsheet Optimization

The major commercial outlets for concentrated barytes are the chemical industry for barium salts manufacturing and the deep well oil exploration activity as weighing agent of drilling muds.

In the latter case granular barytes are preferable due to easier grinding and size control; the presence of small proportions (up to 25 % by weight) of flotation concentrates may be tolerated provided reagent drawbacks are minimized; specific gravity must be at least 4.20 kg/dm^3. The chemical industry accepts either granular or filter cake barytes and sometimes even blends thereof provided that SiO2 content does not exceed 1.5 %.

In view of the above market restrictions as well as the technical processing results for each kind of ore, blending of the various concentrates can be economically beneficial. Different schemes may be devised such as, for instance, blends of all the available products for supplying either the chemical or the oil industry or both, or blends for the oil industry involving jig concentrates only, while the whole flotation concentrate together with part of richer jig concentrate from ore A could be destined to the checimal industry, and so on.

Of course, the most advantageous of the available options will be dictated by the respective proportion of each kind of ore and, above all by the actual market situation (demand and prices).

Currently, owing to the recent fall in oil prices, the demand for drilling muds application, by far the largest for barite concentrates, has suddenly dropped. Consequently, the market structure has undergone a major change compared to the previous period: chiefly to do with the more stringent quality requirements for the different utilizations: oil service companies tend now to refuse blends with products containing flotation reagents, whereas manufacturers of barium salts accept only high grade concentrates with very low pollutants. Moreover, over the last few years market prices have fallen considerably in real terms.

Under these circumstances, the production schedule has had to be adjusted the new problem being that of optimizing production schedule in order to maximize profit while satisfying market demand.

Under the restriction that flotation concentrates are in any case to be destined to the chemical industry alone, the available alternative options consist of either:

- a blend involving the whole jig concentrates production;
- a blend for the oil industry consisting of the entire concentrate from ore B and that part of the concentrate from ore A exceeding the demand of the chemical industry, which presently pays higher prices.

Computer simulation results while confirming that the resort to blending is always profitable, reveal that the first option is better as long as the availability of ore B is greater, otherwise the choice is indifferent. Optimum gravity concentrate grade for each kind of ore separately processed depends of course on the respective proportion of each ore fed to the plant, which in turn is influenced by the available reserves as well as by the mining restrictions.

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