

Present value ratio per vertical column unit of recoverable material in the known maximum 2000 feet pay section, is approximately for each \$9.00 worth of oil there is \$7.00 worth of soda ash and \$2.00 worth of alumina, or about \$3.50 per vertical ton of ore on a weight average basis. Approximate recovered and refined equivalent products, expressed also as a ratio, is one ton of aluminum metal, to sixteen tons of soda ash, to thirty tons of shale oil with each of these being worth roughly \$500.00 at today's market. Thus the total potential value of the basin reserves is approximately tripled by adding the sodium byproducts.

DEVELOPMENT, MINING METHODS, AND COSTS

In proposing open cut mining, I do not mean to totally ignore other methods. Block caving is still a possibility and of course, nuclear blasting may be justified for open cut preparation aside from the in-situ recovery considerations. Various types of very large continuous mining machines and semi-portable belt conveyors should receive careful scrutiny. Dr. Tell Ertl covered the basics in his 1965 paper, although his figures now may be too conservative.

Mining a full section of ore to 3,000 feet deep will need a trench no greater than 6,000 feet wide at the surface in the basin center. This width would decrease toward the basin edge and if controlled, self-induced open caving methods could be perfected, the width would decrease even more, with a corresponding reduction in stripping and blasting costs. Once room was developed to the bottom of the pay section, then overburden and spent shale can be back-filled into the mined out areas and the surface permanently reclaimed for other future uses. The fundamental procedure would be somewhat akin to placer dredge mining operations. Minimum unit rate of mining & stripping production for optimum efficiency would probably not be less than fifty thousand tons per day each from an area of about 5,000 acres per operation. Unitization of land holdings to fit this minimum order of magnitude scope will be desirable.

Initial strip ratio on first cut or pass would be in the vicinity of 1:1 but then would decrease approaching one half to one. Mining costs for ore and waste will be much less than \$0.25 per ton and waste disposal and reclamation less than \$0.10 per ton of material re-handled. Initial capital investment estimates may approach \$250 million for the average operation, but this may vary somewhat depending on variation of factors over the whole basin, and especially the relative stripping ratios required to start production.

These elements can only be removed from the realm of speculation by completely and carefully drilling, sampling and testing, based on a statistical distribution and density of coverage. The next stage may be to confirm these results by sinking shafts and obtaining bulk samples for pilot plant tests. This would also allow for a more accurate appraisal of mining methods and costs, water disposal, availability, requirements and related problems. Such programs often consume five years or more before any real production is achieved. Concurrently, in other areas, other approaches such as underground block-caving, room and pillar, or in situ nuclear blasting techniques should be under way, if the need otherwise continues to be indicated.

Although other power may be available at less cost, conceivably the shale oil (and some soda ash) might be utilized in aluminum reduction. Very cheap soda ash might find and develop new markets eventually, but much would depend on related transportation factors which will also affect the aluminum economics.

In any event, if most of the sorting out is done on a competitive private enterprise basis, in a climate of reasonable and equal rules for all concerned, the result will be the earliest establishment of a most important and worthwhile new industry for the maximum benefit of all.

Permission for this paper was provided by Mr. Joe Juhan of Tucson, Arizona and his assistance, together with that of Mr. Irvin Nielson of Wolf Ridge Minerals, Glenwood Springs, Colorado and Dr. John Anthony, Hawley & Hawley, assaying chemists and others of Tucson, Arizona is acknowledged.

BIBLIOGRAPHY

- Boyd, James, 1967 "The Influence of the Minerals Industry on General Economics" Jackling (Memorial) Lecture A.I.M.E. Los Angeles, Feb. 1967.
 Brant, A. A., 1966 "The Story of Natural Resources and their Historical Impact" Regents Lecture, University of Calif. College of Engineering, Department of Mineral Technology, Berkeley, California.