A minerals data analysis contract report
MAY 1984

FINAL REPORT
DEVELOPMENT OF ENGINEERING AND COST DATA FOR FOREIGN FLUORSPAR PROPERTIES

Contract J0225010
Dames & Moore

Bureau of Mines Open File Report 170-84

BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. BuMines OFR 170-84	2.	3. Recipient's Accession No. PB85 103729
4. Title and Subtitle Development of Engineering and Cost Data for Foreign Fluorspar Properties			5. Report Date May 1984 6.
7. Author(s) Robert B. Fulton III, Gill Montgomery, Mary L. Pearson, and Richard Waissar			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Dames & Moore 1626 Cole Boulevard Golden, CO 80401			10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) J0225010 (G)
12. Sponsoring Organization Name and Address Office of Assistant Director--Minerals Data Analysis Bureau of Mines U.S. Department of the Interior Washington, DC 20241			13. Type of Report & Period Covered Contract research, 9/30/82--3/30/84 14.

15. Supplementary Notes

Approved for release September 5, 1984.

16. Abstract (Limit: 200 words)

This report present summaries of data and estimates for 52 fluorspar properties in the following 13 foreign countries: Mexico, Thailand, China, Morocco, Tunisia, Italy, Spain, the Republic of South Africa, France, the United Kingdom, Kenya, Namibia, and the Federal Republic of Germany. Data includes deposit type, resource tonnage and grades, mining and beneficiation methods, annual production, fluorspar products and by products, work force requirements, and capital and operating cost estimates. For operating properties, engineering and cost data have been developed for present and anticipated levels of production. Hypothetical operations have been assumed for undeveloped deposits.

17. Document Analysis a. Descriptors

Economic analysis
- Fluorspar, foreign
- Exploration
- Resources
- Surface mining
- Underground mining
- Beneficiation
- Capitalized costs
- Operating costs

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group 05C

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release unlimited by NTIS.	Unclassified	43
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

FOREWORD

This report was prepared by Dames & Moore, Golden, Colorado, under USBM Contract number J0225010. The contract was initiated under the Minerals Availability System Program. It was administered under the technical direction of the Minerals Availability Field Office, Denver, Colorado, with Catherine C. Kilgore acting as Technical Project Officer. David J. Askin was the Contract Administrator for the Bureau of Mines. This report is a summary of the work recently completed as a part of this contract during the period September 30, 1982 to March 30, 1984. This report was submitted by the authors on March 16, 1984.

Neither this report nor any of the work previously completed and submitted contains data relating to any item which might be considered to be a Subject Invention.

The compilation of fluorspar data on deposits and operations in the 13 foreign countries studied under this contract could not have been possible without the cooperation of many individuals at all levels of management and staff of the participating organizations. Dames & Moore wishes to take this opportunity to thank those people for taking the time from their busy schedules to assist us with this project. It is our hope that, in having a deeper understanding of the fluorspar industry in those countries, benefits will accrue to the producers of that important commodity.

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INTRODUCTION

Purpose and Scope

The Mineral Availability System (MAS) is designed to collect, store and retrieve high quality technical and economic information on key mineral commodities needed by U.S. industry. Since mineral commodities used in the U.S. are obtained from sources worldwide, the MAS program is worldwide in scope. The MAS system allows assessment of present and future mineral availability and cost, analysis of constraints on availability and cost, and assessment of the impact of changes in technical, political and economic climate on mineral availability and cost.

The purpose of the study was to provide information on location, ore grade, reserves and resources, mining, processing, infrastructure, transportation, environmental, and other production constraints for selected foreign fluorspar mines and deposits. Thirteen countries were included in the project, with the objective being to provide the required data for at least 85 percent of the known fluorspar deposits in each country, thus accounting for over 85 percent of the deposits for the group as a whole. The countries whose fluorspar mines and deposits were studied were:

Mexico
Thailand
China*
Morocco
Tunisia
Italy
Spain
South Africa
France
United Kingdom
Kenya
Namibia
Federal Republic of Germany

*Peoples Republic of China

In all, 52 mines and/or deposits were studied. Usually, the beneficiation plant was taken as the base, with the plant, the mines feeding it, and all associated undeveloped deposits being considered one property for the purpose of developing a single profile report. In a few cases, however, large undeveloped deposits or fluorspar districts were studied. Profile reports in those cases were based upon the known geological data with cost estimates being made assuming that the properties would be placed in production at some time in the future.

Methodology

The methodology employed in collecting the data and preparing the profile reports may be summarized as follows:

Step 1: A comprehensive literature search, on a country-by-country basis, was made for each deposit. Sources included both government and trade publications.

Step 2: Key officers and managers of the companies in question were contacted by letter to solicit their cooperation and to make arrangements to visit the offices and properties of the firms. After two to three weeks had passed, the letters were followed up by telephone calls.

Step 3: Forms were prepared to aid the field investigator in the data collection process. In some cases, the forms were translated into the language of the country in question to facilitate working with company staff personnel at the properties.

Step 4: Having made arrangements with company officials to visit the properties and collect data, the properties were grouped by geographic area and route to reduce travel costs and time, and site visits were made by an investigator. The grouping employed was as follows:

Group 1 - Mexico

Group 2 - China
Thailand
Tunisia
Morocco

Group 3 - South Africa
Namibia
Kenya
Italy
France
Spain
United Kingdom

Group 4 - Federal Republic of Germany

The Group 4 properties would appear to fall more logically with other European properties of Group 3. These properties, however, were substituted for others near the end of the project when it was discovered that deposits on the original list were unsuitable for inclusion in the study.

Step 5: The field investigator prepared a draft report for each property he visited. The engineering staff of the Denver office of Dames & Moore then made engineering and cost estimates if required and prepared the draft profile report for submittal to the Technical Project Officer (TPO).

Step 6: Upon receipt of questions and comments from the TPO, the final profile report was prepared and submitted to the TPO at the Minerals Availability Field Office.

Confidentiality

At all times it was made clear to the company officials and staff personnel who cooperated with Dames & Moore that data which they wished to remain confidential would be kept so. Cost data and mill recoveries almost always fell into this category. In many cases, companies wished to keep ore reserve grades and tonnages confidential as well.

COMPANIES/MINES/DEPOSITS

Final USBM RFP List

The original list of companies/mines/deposits that appeared in the USBM's RFPJ0225010, is shown in Table 1. As shown, this list contained 54 deposits located in nine countries. Prior to awarding the contract, the USBM solicited assistance from bidders in revising this list. Several deletions and substitutions were subsequently made during the course of the study as described in the next section.

Modifications Prior to Contract Award

Several deletions to the original list, listed below, were made prior to the contract award. The reasons for these deletions are as follows:

Mexico

The La Consentida Mine was reportedly closed, but undergoing a deep drilling program by Noranda. The deposit was deleted pending discussions with Noranda regarding the status and results of their exploration program.

Los Cayos Mine was reported to be depleted of reserves.

Mineria Continental is a brokerage subsidiary of IMC in Mexico City and not an operating company. IMC is an owner of Fluorita de Mexico, among others.

The Parral fluorspar deposit was listed redundantly since San Francisco del Oro and the Fluorita Unit of Zinc de Mexico already appear on the list.

The Santa Rosa Mine was shut down and reportedly depleted of reserves.

Spain

The Arlos deposit is no longer in operation and is reported to be largely depleted.

The Sierra de Baza Deposit was included in the Minersa operations in Asturias and it was anticipated that one profile report would address all the operations.

Italy

The Dezzo Deposit was eliminated because there was no knowledge of its existence. It is believed that it was an old operation that had been abandoned or was under new ownership.

The Mozzolombardo, Prestavel, and Torgola Deposits are idle Fluormine operations in northern Italy.

TABLE 1. - Original company/mine/deposit list as shown in USBM RFPJO225010

MEXICO
- Fluorita de Mexico*
- Fluorita Unit*
- La Consentida Mine
- La Dominica Mine
- Las Cuevas Mine
- Los Cayos Mine
- Mineria Continental*
- Parral Fluorspar Deposit*
- Realito Mine
- Santa Rosa Mine
- Rio Colorado/Rio Verde Mines*
- San Francisco del Oro (Co.)*
- Seaforth Mineral and Ore Co.*

SPAIN
- Arlos Deposit
- Fluoruros (Co.)*
- Ribadesella-Asturias Deposit
- Sierra de Baza Deposit
- Villabona-Asturias Deposit

ITALY
- Dezzo Deposit
- Mezzolombardo Deposit
- Monreale Mine
- Pianciano Deposit
- Prestavel Deposit
- Sardinia Operations*
- Torgola Deposit

KENYA
- Kerio Valley

MOROCCO
- El Hammam Deposit

U.K.
- British Steel Company*
- LaPorte Operations*
- Dresser Minerals Int.*
- Samuk District*

FRANCE
- Alban Mine
- Fontsante/Langeac Mines*
- Montroc Deposit
- Reclense/d'Argentolle Mines*
- Escarro Deposit
- Mine de Rossignol

SOUTH AFRICA
- Armco Inc.*
- Buffalo Fluorspar*
- Chemspar Ltd.*
- Marico Fluorspar*
- Ruigtepoort Fluorspar Ltd.*
- Vergenoeg Mining Co. Ltd.*

THAILAND
- Ban Hong District*
- Mae Ta District*
- Phanom Thuan District*
- Research & Resources Co.*
- Si Sawat District*
- Thai Fluorspar & Minerals Co.*
- Thai Fluorite Processing Co.*
- Thai Resources Development Co.*
- Thepnithi Co.*
- United Fluorite Mining Co.*
- Universal Mining Co.*

*The profile report may include more than one mine/deposit.

Thailand

The Research and Resources Company and Universal Mining Company were deleted by the USBM based on another bidder's recommendation. The nature of Thai operations made it virtually impossible to finalize the list until the country was visited.

Modifications During Contract Performance

Upon visiting the fluorspar producers, several additional deletions were made. These deletions are specified below along with their justifications.

Thailand

The Ban Hong District was found to be depleted of reserves and was therefore deleted from the list.

Thai Resources Development Company was not in existence.

China

The Lunghua, Pecheng, Taoling, and Kai Ping Districts were deleted at the discretion of the officials of the Chinese Ministry of Metallurgical Industries who indicated that these districts contain very small and insignificant deposits. Guangdong Province was deleted for the same reason.

Italy

Sarramin in Sardinia has exhausted its reserves.

Spain

Minas Villabona has ceased to operate because of the exhaustion of its reserves.

Unisur was inactive due to the poor market and is very near depletion of its reserves. It is unlikely it will reopen.

South Africa

The Ruigtepoort Fluorspar, Ltd. deposit has been exhausted and abandoned.

The ARMCO deposit was sold to SAMANCOR and is described as the Transvaal Fluorspar deposit.

United Kingdom

The United Kingdom operations went through substantial reorganizations which resulted in changes to the original list. The only deletion from the list was the Dresser Minerals operations which were reportedly exhausted. LaPorte now owns the mill and property formerly owned by Dresser. British Steel and Alusuisse have both been acquired by Minworth and are included under different names.

Substitutions

After deleting the above deposits, several substitutions were made to maintain a list of 52 companies/mines/deposits, and also to maintain the coverage of 85 percent of the resources of the countries included in the study. With this in mind, the following substitutions were made.

Mexico

In essence, all of the eight deposits specified on the final approved list were present on the original RFP list with the following clarifications:

- Zinc de Mexico is shown as the Fluorita Unit on the original list.
- Minerales y Productos Metalurgicos is shown as Seaforth Mineral and Ore Company on the original list and reflects a change in ownership.
- Rio Verde is the company which operates the Realito Mine.
- Rio Colorado is the company which operates the El Refugio Mine.

Thailand

SK Minerals was added to the list prior to contract award as a substitution for the Research and Resources Company.

The Mae Tha District was found to have two operators; Universal and Thepnithi. These have been separated into two entities. In addition, Universal operates the Mae La Luang Mine which has been substituted for Thai Resources Development Company.

United Fluorite Company had two operations at Takien Ngam and Salak Pra. One of these was substituted for the Ban Hong District which was deleted from the list.

China

The Shangdong Province was separated into two operations consisting of the Fu Shan and Xian Shan Mills which are both supplied by one mining district.

The following deposits were substituted for deletions made at the discretion of the Chinese Ministry of Metallurgical Industries:

- Hei Shao Tou/Bai Yun He Pe Mine/Mill complex in Inner Mongolia,
- Da Gai Tang/Hua De Mine/Mill complex in Inner Mongolia,
- Hong An District in Hubei Province, and
- De An District in Jiangxi Province.

Italy

Domusnovas in Sardinia is an undeveloped resource and was substituted for Sarramin's depleted deposit in Sardinia.

South Africa

The Kruidfontein Deposit owned by Southern Sphere is an undeveloped resource and was substituted for the exhausted Ruigtepoort operation.

France

The Morvan Deposits in France were substituted for Reclensne d'Argentolle whose operations were closed due to depletion. The Morvan Deposits are an undeveloped resource covering a large area of France and representing substantial reserves.

United Kingdom

The substitutions here are in name only. The former British Steel operations now owned by Minworth are designated as the Blackdene Mill and Mines, and the former Alusuisse operations are designated as the Broadwood Mill and Mines.

Federal Republic of Germany

Two deposits in the Federal Republic of Germany were added to substitute for a lack of deposits elsewhere in Europe. These consisted of Bayer and Sachtleben Bergbau.

Final Approved List

The result of the aforementioned deletions and substitutions is shown in Table 2 which presents the Final Approved List of Companies/Mines/Deposits. These 52 deposits in 13 countries have been visited and investigated by Dames & Moore during the course of this study. Confidential Profile Reports were prepared for each of these deposits and form the basis for the remainder of this report.

TABLE 2. - Final approved list of companies/mines/deposits

MEXICO

1. San Francisco del Oro
2. Zinc de Mexico
3. La Domincia
4. Minerales y Productos Metalurgicos
5. Fluorita de Mexico
6. Rio Verde
7. Rio Colorado
8. Las Cuevas

THAILAND

9. SK Minerals
10. Thai Fluorite Processing
11. Phanom Tuan
12. Thai Fluorspar & Minerals
13. Thepnithi Co.
14. Mae Tha, Universal
15. Mae La Luang, Universal
16. Salak Pra, United
17. Takien Ngam, United

CHINA

18. Wuyi District
19. Hei Shao Tou/ Bai Yun He Pe
20. Da Gai Tang/Hua De
21. Hong An District
22. De An District
23. Fu Shan Mill
24. Xian Shan Mill

MOROCCO

25. El Hammam

TUNISIA

26. Hammam Zriba

ITALY

27. Pianciano
28. Mineria Silius
29. Domusnovas

SPAIN

30. Gijon Area
31. Fluoruros
32. Torre Mill, Minersa
33. Minas de Orgiva

SOUTH AFRICA

34. Buffalo, General Mining
35. Witkop Mine
36. Marico, Rand Mines
37. Vergenoeg Fluorspar
38. Transvaal Fluorspar
39. Kruidfontein Fluorite

FRANCE

40. Le Burc, Sogerem
41. Montroc, Sogerem
42. Morvan District
43. Comifluor (Escarro)
44. SIC Mine de Rossignol
45. SECEME (Fontsante)

UNITED KINGDOM

46. Blackdene Mill & Mines
47. Broadwood Mill & Mines
48. La Porte-Derbyshire District

KENYA

49. Kenya Fluorspar Co.

NAMIBIA

50. Okorusu

FEDERAL REPUBLIC OF GERMANY

51. Bayer
52. Sachtleben Bergbau

RESOURCE AND PRODUCT SUMMARY

Each of the 52 project sites have been categorized with respect to deposit type, reserves, and products. This section summarizes the variations found within these categories and presents a tabulation for each project site. In order to maintain confidentiality of individual company data, a rating system has been devised. Ratings of low, medium, and high are defined for reserves and grade in this section.

Deposit Type

The 52 foreign fluorspar deposits studied during this contract exhibit a wide variety of deposit types. Ten different modes of occurrence have been identified.[1] A brief description of these ten varieties is provided here, and the applicable deposit type for each of the 52 sites is shown in Table 3 at the end of this section.

(1) Fissure Veins: Fissure vein deposits commonly occur along faults or shear zones and are the most readily recognized form of fluorspar occurrence in the world. Although the vein structure may be persistent, the fluorspar mineralization commonly occurs as lenses or ore shoots separated by barren zones. Fissure veins occur in igneous, metamorphic, and sedimentary rocks.

(2) Stratiform Deposits: Stratiform, manto, or bedded deposits occur as replacements in carbonate rocks. Some beds are replaced adjacent to structural features such as joints and faults. In frequent instances, there is a capping of sandstone, shale, or clay.

(3) Replacement Deposits: Replacement deposits in carbonate rocks along the contact with acidic igneous intrusives are another common type of deposit. Deposits do not have to be the result of contact metamorphism, but may be introduced later, following the contact zone as a conduit and replacing the limestone.

(4) Stockworks: Fluorspar often occurs as stockworks and fillings in shear and breccia zones.

(5) Carbonatite and Alkalic Rock Complexes: Fluorspar may be found at the margins of carbonatite and alkalic rock complexes; however, it is rarely in sufficient abundance to be economic.

(6) Residual Deposits: Concentrations of fluorspar in clayey and sandy residuum resulting from surficial weathering of fluorspar veins and replacement deposits in some places are sources principally of metallurgical spar. This includes detrital deposits blanketing the apex of veins,

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[1] Fulton, R.B., and G. Montgomery. Fluorspar and Cryolite. Ch. in Industrial Minerals and Rocks, ed. by S.J. Lefond. AIME, New York, 5th ed., 1983, pp. 723-744.

and the upper portions of the veins themselves that have been deeply weathered to depths of 100 feet or more.

(7) Gangue Mineral: Fluorspar occurs as a major gangue mineral in lead-zinc veins in many parts of the world.

(8) Breccia Pipes: Fluorite occurs in less common instances as fillings in breccia pipes.

(9) Fillings in Open Spaces: Fluorite is occasionally found in partially filled open spaces in either vein or stratiform deposits.

(10) Lake Sediments: Fluorspar may occur in unconsolidated clayey and sandy pyroclastic sediments in the beds of former lakes. Fluorspar is present as finely disseminated crystals.

Demonstrated and Identified Resources

As part of the contract to develop engineering and cost data for the specified foreign fluorspar properties, a compilation of fluorspar resources was developed. These resources are categorized as demonstrated and identified. Demonstrated resources are defined as being equal to the sum of measured and indicated resources, and may be considered to be 75 percent probable. Identified resources equal the sum of measured, indicated, and inferred resources, and may be considered to be 50 percent probable.

Table 3 documents the in situ, demonstrated, and identified resources for each of the 52 project sites. In order to keep individual company data confidential, the resources have been assigned ratings of low, medium, or high, based on the following ranges.

Demonstrated Resources	Range of In Situ Tonnage, mt
Low	less than 2,000,000
Medium	2,000,000 to 5,000,000
High	greater than 5,000,000

Identified Resources	Range of In Situ Tonnage, mt
Low	less than 5,000,000
Medium	5,000,000 to 10,000,000
High	greater than 10,000,000

Ore Grade

The grade of in situ resources corresponding to the demonstrated and identified tonnages have been represented by a rating of low, medium, or high on Table 3. These ratings are defined as follows:

In Situ Ore Grade	Range of Analysis, $\%CaF_2$
Low	less than 40
Medium	40 to 60
High	greater than 60

Products

During the course of this study, the traditional fluorspar products such as metallurgical gravel, metallurgical briquettes, ceramic grade concentrate, and acid grade concentrate were documented. Various other fluorspar products included flotation mill feed in instances where mines could not support their own mill, and sub-acid grade where an attempt was being made to market a middling flotation product. The specific fluorspar products for each of the 52 project sites are listed in Table 3.

In a few instances, by-products are generated in addition to the fluorspar products. These by-products include barite products, lead concentrates, aggregates, or a combination thereof. The specific by-products for the 52 project sites are listed in Table 3.

TABLE 3. - Resource and product summary for foreign fluorspar deposits

Property name	Deposit type	Resources				Products	
		Demonstrated		Identified			
		Tonnage	Grade	Tonnage	Grade	Fluorspar	By-products
Mexico							
1) San Francisco del Oro	Gangue Mineral	Medium	Low	Medium	Low	Acid Grade Conc.	None
2) Zinc de Mexico	Gangue Mineral	Medium	Low	High	Low	Acid Grade Conc.	None
3) La Domincia	Replacement	Medium	High	Low	High	Acid Grade Conc.	None
4) Minerales y Productos Metalurgicos	Fissure Vein	Low	Medium	Low	Medium	Acid Grade Conc. Metallurgical Gravel	None
5) Fluorita de Mexico	Stratiform	Medium	High	Low	High	Acid Grade Conc.	None
6) Rio Verde	Replacement	Medium	High	Low	High	Acid Grade Conc. Metallurgical Grade	None
7) Rio Colorado	Replacement	Low	High	Low	High	Acid Grade Conc. Ceramic Grade Metallurgical Grade	None
8) Las Cuevas	Replacement	High	High	High	High	Acid Grade Conc. Metallurgical Grade	None
Thailand							
9) SK Minerals	Fissure Vein	Low	Medium	Low	Medium	Acid Grade Conc.	None
10) Thai Fluorite Processing	Fissure Vein	Low	Medium	Low	Medium	Acid Grade Conc.	None
11) Phanom Thuan	Replacement	Low	Medium	Low	Medium	Metallurgical Grade Flotation Mill Feed	None
12) Thai Fluorspar & Minerals	Stockworks (possibly a breccia pipe)	Low	Low	Low	Low	Flotation Mill Feed	None

TABLE 3. - Resource and product summary for foreign fluorspar deposits - Continued

Property name	Deposit type	Resources				Products	
		Demonstrated		Identified			
		Tonnage	Grade	Tonnage	Grade	Fluorspar	By-products
Thailand (Continued)							
13) Thepnithi Company	Fissure Vein	Low	Medium	Low	Medium	Metallurgical Grade	None
14) Universal at Mae Tha	Fissure Vein	Low	Low	Low	Low	Metallurgical Grade	None
15) Universal at Mae La Luang	Fissure Vein	Low	High	Low	High	Metallurgical Grade	None
16) United at Salak Pra	Fissure Vein	Low	Medium	Low	Medium	Metallurgical Grade Flotation Mill Feed	None
17) United at Takien Ngam	Fissure Vein	Low	High	Low	High	Metallurgical Grade	None
China							
18) Wuyi District	Fissure Vein	High	High	High	High	Acid Grade Conc. Metallurgical Grade	None
19) Hei Shao Tou/ Bai Yun He Pe	Fissure Vein	Low	High	Low	High	Acid Grade Conc. Metallurgical Grade	None
20) Da Gai Tang/Hue De	Fissure Vein	Low	High	Low	High	Acid Grade Conc. 2 Grades of Metallurgical Lump	None
21) Hong An District	Fissure Vein	High	High	Medium	High	Acid Grade Conc. Metallurgical Grade	None
22) De An District	Replacement	High	Medium	High	Medium	Acid Grade Conc. Ceramic Grade Conc. Metallurgical Grade	None
23) Fu Shan*	Fissure Vein	Medium	High	Medium	High	Acid Grade Conc.	None
24) Xian Shan*	Fissure Vein	Medium	High	Medium	High	Acid Grade Conc.	None

*Fu Shan and Xian Shan are supplied by the same mining district at Pong Lai.

TABLE 3. - Resource and product summary for foreign fluorspar deposits - Continued

Property Name	Deposit type	Resources				Products	
		Demonstrated		Identified			
		Tonnage	Grade	Tonnage	Grade	Fluorspar	By-products
Morocco							
25) El Hammam	Fissure Vein	Low	Medium	Low	Medium	Acid Grade Conc.	None
Tunisia							
26) Hammam Zriba	Stratiform	High	Low	High	Low	Acid Grade Conc.	None
Italy							
27) Pianciano	Lake Sediments	High	Medium	High	Medium	Metallurgical Briquettes	None
28) Mineria Silius	Fissure Vein	High	Medium	High	Medium	Acid Grade Conc. Metallurgical Grade OMCA Barites	Lead Concentrate Barite Concentrate
29) Domasnovas	Replacement	Medium	Low	Low	Low	Acid Grade Conc.	None
Spain							
30) Minersa at Gijon	Stratiform and Fissure Vein	High	Low	High	Low	Acid Grade Conc. Ceramic Grade Conc.	None
31) Fluoruros	Stratiform and Fissure Vein	High	Low	Medium	Low	Acid Grade Filter Cake Dried Acid Grade Conc. Ceramic Grade Metallurgical Grade	None
32) Minersa at Ribadesella	Stratiform	High	Low	Medium	Low	Acid Grade Conc. Ceramic Grade Conc.	None
33) Minas de Orgiva	Stratiform	High	Low	High	Low	Acid Grade Conc. Sub-Acid Grade	Lead Concentrate

TABLE 3. - Resource and product summary for foreign fluorspar deposits - Continued

Property name	Deposit type	Resources				Products	
		Demonstrated		Identified			
		Tonnage	Grade	Tonnage	Grade	Fluorspar	By-products
South Africa							
34) Buffalo Mine	Stockworks	High	Low	High	Low	Acid Grade Conc. Ceramic Grade Conc. Metallurgical Grade	None
35) Witkop Mine	Replacement	High	Low	High	Low	Acid Grade Conc.	None
36) Marico Mine	Replacement and Residual	High	Low	High	Low	Acid Grade Conc.	None
37) Vergenoeg	Stockworks	High	Low	High	Low	Acid Grade Conc.	None
38) Transvaal Fluorspar	Replacement	High	Low	High	Low	Acid Grade Conc.	None
39) Kruidfontein Deposit	Stockworks	High	Low	High	Low	Acid Grade Conc. Metallugical Grade Ceramic Grade	None
France							
40) Le Burc	Fissure Vein	Low	High	Low	High	Acid Grade Conc. Metallurgical Grade	None
41) Montroc	Fissure Vein	Low	High	Low	High	Acid Grade Conc. Ceramic Grade	None
42) Morvan District	Fissure Vein and Stratiform	High	Low	High	Low	Acid Grade Conc.	None
43) Escarro	Stratiform	Low	Medium	Low	Medium	Acid Grade Conc.	None
44) Rossignol	Fissure Vein	Low	High	Low	High	Metallurgical Grade	Pb-Barite Conc.
45) Fontsante	Fissure Vein	Low	Medium	Low	Medium	Acid Grade Conc.	None

TABLE 3. - Resource and product summary for foreign fluorspar deposits - Continued

Property name	Deposit type	Resources				Products	
		Demonstrated		Identified			
		Tonnage	Grade	Tonnage	Grade	Fluorspar	By-products
United Kingdom							
46) Minworth at Blackdene	Fissure Vein, Stratiform, and Dumps	Medium	Medium	Low	Medium	Acid Grade Conc.	Lead Concentrate
47) Minworth at Broadwood	Fissure Vein, Stratiform, Dumps, Stope Fill	Medium	Medium	Medium	Medium	Acid Grade Conc.	Lead Concentrate
48) LaPorte at Derbyshire	Stratiform	Medium	Low	Medium	Low	Acid Grade Conc.	None
Kenya							
49) Kenya Fluorspar Co.	Fissure Vein and Replacement	High	Medium	Medium	Medium	Acid Grade Conc.	None
Namibia							
50) Okorusu	Carbonatite and Alkalic Rock Complexes	High	Medium	Medium	Medium	Metallurgical Grade	None
Federal Republic of Germany							
51) Bayer	Fissure Vein	W	W	W	W	Acid Grade Conc.	None
52) Sachtleben Bergbau GMBH	Fissure Vein	W	W	W	W	Acid Grade Conc.	3 Barite Products

W - Withheld

OPERATION SUMMARY

Of the 52 foreign fluorspar sites studied during this contract, 6 deposits were undeveloped resources and 46 deposits were active operations. The active operations were documented according to the actual mining and milling methods in use. The undeveloped deposits required the design of a hypothetical operation. In designing the hypothetical operations, consideration was given to the geometry of the ore body, the level of technology available at the particular site, environmental constraints, and the market for specific products, among others.

At the time the site visits were being made, owners were extremely sensitive about divulging details of their operations. In most cases, mines were operating at substantially reduced capacities due to slack market conditions. In some instances, mines were idle and depleting stockpiles of products. This section describes the actual and hypothetical fluorspar operations at the 52 project sites. For individual company data that has to remain confidential, a rating system has been developed. Table 4 presents the findings of this study with regard to the operating parameters of annual production, manpower, mining method(s), mine operating cost estimates, milling methods, and mill operating cost estimates.

Definition of Operations Ranges

The following ranges have been defined for production, mine and mill operating costs, and manpower requirements in order to maintain confidentiality of individual company data. These ranges apply to the data presented in Table 4.

Production of Ore	Range of Annual Tonnage, mt
Low	less than 100,000
Medium	100,000 to 500,000
High	greater than 500,000

Mine Operating Costs	Range of Costs, $/mt Ore
Low	less than 10.00
Medium	10.00 to 20.00
High	greater than 20.00

Mill Operating Costs	Range of Costs, $/mt Ore
Low	less than 7.00
Medium	7.00 to 14.00
High	greater than 14.00

Manpower Requirement	Range of Total Manpower at Operation
Low	less than 100
Medium	100 to 200
High	greater than 200

Cost Estimation Techniques

Where cost estimation was necessary, Dames & Moore relied upon past project experience and comparison with other foreign fluorspar properties. Cost estimates were made to within ± 25% of actual based on this practice.

In most instances, labor costs could be generated from data provided by the individual company or based upon comparison with similar operations within the same geographic region. Having this information as a basis, Dames & Moore was able to generate total mine and mill operating costs utilizing experience and knowledge of constituent costs for various mining and milling methods. The resulting operating cost ranges for each of the 52 project sites are shown in Table 4.

TABLE 4. - Summary of operations for foreign fluorspar deposits

Property name	Deposit type	Annual Mine production	Manpower	Mining method(s)	Milling method(s)	Operating Costs	
						Mine	Mill
Mexico							
1) San Francisco del Oro	Gangue Mineral, tailings	High	Medium	Shrinkage Stope	Flotation	Low	Low
2) Zinc de Mexico	Gangue Mineral	High	Low	Hydraulic Mining	Flotation	Low	Low
3) La Domincia	Replacement	Medium	High	Sublevel Stope/ Room and Pillar	Flotation	Medium	High
4) Minerales y Productos Metalurgicos	Fissure Vein	Low	Low	Shrinkage Stope	Flotation	Medium	Medium
5) Fluorita de Mexico	Stratiform	Medium	Medium	Room and Pillar	Flotation	High	Medium
6) Rio Verde	Replacement	Medium	Medium	Cut and Fill	Gravity, Flotation	High	High
7) Rio Colorado	Replacement	Medium	Medium	Cut and Fill	Gravity, Flotation	High	High
8) Las Cuevas	Replacement	High	High	Shrinkage Stope/ Sublevel Caving	Flotation	High	Medium
Thailand							
9) SK Minerals	Fissure Vein	Medium	Medium	Open Pit	HMS, Flotation	Low	Medium
10) Thai Fluorite Processing	Fissure Vein	Low	High	Open Pit/ Shrinkage Stope	Flotation	High	Medium
11) Phanom Thuan	Replacement	Low	High	Open Pit	Hand Sorting	Medium	NAp
12) Thai Fluorspar & Minerals	Stockworks (possibly a breccia pipe)	Low	Low	Open Pit	Hand Sorting	Low	NAp
13) Thepnithi Company	Fissure Vein	Low	Medium	Open Pit	Hand Sorting	Medium	NAp
14) Universal at Mae Tha	Fissure Vein	Medium	Medium	Reprocessing Dumps	HMS	NAp	Low
15) Universal at Mae La Luang	Fissure Vein	Low	Medium	Open Stope	Hand Sorting	Medium	NAp
16) United at Salak Pra	Fissure Vein	Low	Medium	Open Pit/Open Stope	Hand Sorting	Low	NAp
17) United at Takien Ngam	Fissure Vein	Low	Medium	Open Pit	Hand Sorting	High	NAp

NAp - Not Applicable

TABLE 4. - Summary of operations for foreign fluorspar deposits - Continued

Property name	Deposit type	Annual Mine production	Manpower	Mining method(s)	Milling method(s)	Operating costs	
						Mine	Mill
China							
18) Wuyi District	Fissure Vein	High	High	Shrinkage Stope	Flotation	Low	Medium
19) Hei Shao Tou/ Bai Yun He Pe	Fissure Vein	Low	High	Shrinkage Stope	Flotation	Low	High
20) Da Gai Tang/Hue De	Fissure Vein	Low	Medium	Shrinkage stope	Flotation	Medium	Low
21) Hong An District	Fissure Vein	Medium	High	Backfilled Sublevel Stope	Flotation	Low	Medium
22) De An District	Replacement	Medium	High	Open Pit	Flotation	Low	Low
23) Fu Shan	Fissure Vein	Low	High	Shrinkage Stope	Hand Sort/ Flotation	Medium	Medium
24) Xian Shan	Fissure Vein	Low	High	Shrinkage Stope	Hand Sort/ Flotation	Medium	Medium
Morocco							
25) El Hammam	Fissure Vein	Medium	High	Shrinkage Stope	HMS/Flotation	Low	High
Tunisia							
26) Hammam Zriba	Stratiform	Medium	High	Room and Pillar	Flotation	Low	Medium
Italy							
27) Pianciano	Lake Sediments	Medium	Low	Strip Mining	Sizing/Gravity/ Pelletizer(proposed)	Low	Medium
28) Mineria Silius	Fissure Vein	Medium	High	Sublevel Stope	Flotation	Medium	Low
29) Domasnovas	Replacement	Medium	Low	Open Pit	Flotation	Low	Low

TABLE 4. - Summary of operations for foreign fluorspar deposits - Continued

Property name	Deposit type	Annual Mine production	Manpower	Mining method(s)	Milling method(s)	Operating costs	
						Mine	Mill
Spain							
30) Minersa at Gijon	Stratiform and Fissure Vein	Medium	Low	Room and Pillar	Flotation	High	Low
31) Fluoruros	Stratiform and Fissure Veins	Medium	Medium	Open Pit/ Room and Pillar	HMS/Flotation	Medium	Low
32) Minersa at Ribadesella	Stratiform	Medium	Low	Open Pit/ Room and Pillar	Flotation	High	Low
33) Minas de Orgiva	Stratiform	Medium	Medium	Room and Pillar	Flotation	High	Medium
South Africa							
34) Buffalo Mine	Stockworks	High	High	Open Pit	HMS/Flotation	Low	Low
35) Witkop Mine	Replacement	Medium	Medium	Open Pit	Flotation	Low	Medium
36) Marico Mine	Replacement and Residual	High	Medium	Open Pit	Flotation	Low	Low
37) Vergenoeg	Stockworks	Medium	Medium	Open Pit	Flotation	Low	Medium
38) Transvaal Fluorspar	Replacement	High	High	Room and Pillar	Flotation	Low	Low
39) Kruidfontein Fluorite	Stockworks	High	High	Open Pit	Flotation	Low	Medium
France							
40) Le Burc	Fissure Vein	Low	Low	Overhead Slicing	HMS	High	Medium
41) Montroc	Fissure Vein	Medium	Low	Open Pit	Flotation	Medium	Medium
42) Morvan District	Fissure Vein and Stratiform	High	Low	Open Pit	Flotation	Medium	Medium
43) Escarro	Stratiform	Medium	Low	Open Pit	Flotation	Medium	High
44) Rossignol	Fissure Vein	Low	Low	Shrinkage Stope	HMS	High	Low
45) Fontsante	Fissure Vein	Medium	Medium	Shrinkage Stope	Flotation	High	Medium

TABLE 4. - Summary of operations for foreign fluorspar deposits - Continued

Property name	Deposit type	Annual Mine Production	Manpower	Mining method(s)	Milling method(s)	Operating costs	
						Mine	Mill
United Kingdom							
46) Minworth at Blackdene	Fissure Vein, Strati-form, and Dumps	Low	Medium	Sublevel or Open Stope	Flotation	High	High
47) Minworth at Broadwood	Fissure Vein, Strati-form, Dumps, Stope Fill	Medium	Medium	Shrinkage Stope	HMS/Flotation	Medium	Medium
48 LaPorte at Derbyshire	Stratiform	Medium	High	Underground	Flotation	Low	Medium
Kenya							
49) Kenya Fluorspar Co.	Fissure Vein and Replacement	Medium	High	Open Pit	Flotation	Low	High
Namibia							
50) Okorusu	Carbonatite and Alkalic Rock Complexes	High	Medium	Open Pit	Flotation	Low	Low
Federal Republic of Germany							
51) Bayer	Fissure Vein	W	W	Cut and Fill	Flotation	W	W
52) Sachtleben Bergbau GMBH	Fissure Vein	W	W	Sublevel Stope	HMS/Flotation	W	W

W - Withheld

COUNTRY OVERVIEWS

A summary of each of the 13 countries studied during this contract is presented below. This discussion is intended to provide a summary of the level of development, market destinations, and constraints to future development of foreign fluorspar resources.

Mexico

Mexican fluorspar mines are basically grouped in four regions. The State of Coahuila in northern Mexico has two producers, the Parral District has two producers of by-product fluorspar, the State of Durango has one small producer, and the Zaragosa District has three large operations, one of which is the largest in the world.

Mexican fluorspar mines were operating at substantially reduced capacities at the time of this study, but the country still remains the world's largest producer. The Mexican operations studied during this contract produce metallurgical grade, ceramic grade, and acid grade concentrates. None of the operations have any salable by-products, although fluorspar is a by-product of metal mining in the Parral District operations of Zinc de Mexico and San Francisco del Oro.

The fluorspar industry in Mexico is currently developed to a level beyond market demands as evidenced by the reduction in capacity of many producers. Mexico is also facing greater competition for its long-standing consumers in the U.S. China has become a strong competitor in the metallurgical markets, and South Africa is becoming a greater source of acid grade concentrates.

There are three primary destinations for Mexican fluorspar. Destinations are defined as the point of sale rather than the point of consumption. Mexican destinations are Tampico; Brownsville, Texas; or Marathon, Texas. Shipments by rail also cross the U.S. border at El Paso and Eagle Pass, Texas. Consumers of Mexican fluorspar are predominantly U.S. steel and chemical industries; however, Canada, Europe, and South America also provide markets. Domestic consumption of acid grade concentrate has also increased. There are currently four hydrofluoric acid plants in Mexico.

When this study commenced in 1982, the fluorspar industry was influenced by the Mexican Fluorspar Institute which established prices. It was particularly difficult to assess dollar costs during the study due to the fluctuation in the exchange rate for the Mexican peso. During 1982, the value of the peso with respect to the dollar dropped considerably, complicating cost analyses. As of January 21, 1983, official fluorspar pricing was abolished and operators were allowed to set their own prices in competition with other producers.

Other than the current economic climate, there are no major constraints to development in Mexico. However, in view of the idle production capacity of several operators, it is doubtful that new developments will emerge in the near future.

Thailand

Fluorspar is produced in Thailand from deposits in three general areas: 1) from Mae Hong Son, the northwesternmost province, eastward through Chiang Mai into Lamphun Province, known as the northern sector; 2) in the provinces of Kanchanaburi, Ratchaburi and Phetchaburi, situated west of Bangkok, known as the middle sector; and 3) in Krabi Province, southeast of Phuket, known as the southern sector. Acid grade concentrate is produced by Krabi International Fluorite Company (KIF), also known as SK Minerals, located near Khlong Thom in Krabi Province, and Thai Fluorite Processing Company (TFP), located at Ban Lard in Phetchaburi Province. Two other companies produce most of the metallurgical grade made in Thailand: United Fluorite Mining Company (UFM), which has two active mines in Kanchanaburi Province, and Universal Mining Company (UMC), which has two active mines; one in Kanchanaburi, operated through its wholly owned subsidiary Phanom Thuan Mining Company, and one at Mae La Luang in Mae Hong Son Province. In addition, UMC produces metallurgical grade by heavy media separation from old mine dumps in the northern sector at Mae Tha, where dumps from this formerly important mining area contain substantial unrecovered fluorspar.

Resources in Thailand were particularly difficult to assess since the operators do not use conventional exploration methods. Most operations simply begin by working the outcrops and continue mining the exposed ore until the particular body is exhausted or becomes uneconomic. With the abundance of present and past operations, which depended on the happenstance of outcrop discovery in largely jungle-covered terrain, one can reasonably suppose that systematic exploration would disclose significant reserves, perhaps several-fold those estimated in this study. Reserves could conceivably even be an order of magnitude greater, or more.

The documentation of relatively small ore reserves from limited exploration should not be taken as an indicator of overall paucity of ore, nor should it be inferred from the number of exhausted ore bodies that Thailand is "running out" of ore. The history of Thai fluorspar mining has been one of digging on outcrops without fully exploring the ore bodies first. In an economically attractive market, conducive to adequate exploration manned by knowledgeable people, it is likely that substantial additional ore will be found. Also, not to be discounted, is the work of the small miners who may happen onto larger ore bodies.

At present, weak world markets are impeding exploration expenditures. Demand for both acid grade and metallurgical is down in Japan, which has been Thailand's principal market for both grades. Competition from China in supplying the Japanese market is also dampening enthusiasm for stronger development in Thailand. Internal consumption of fluorspar in Thailand is less than 500 mtpy.

The Soviet Union has recently contracted with a Thai producer for 40,000 mtpy for five years which will provide a much needed boost to the industry.

Export destinations for Thailand's products are generally at Bangkok Harbor. One operator has established a shipping point on the western coast at Kan Tang for consumers in India. This represents a considerable savings in shipping costs. Consumers of Thailand's fluorspar are predominantly Japan and the USSR. Others include Australia, India, Indonesia, South Korea, Malaysia, the Netherlands, and Taiwan.

There are no major constraints to further development of fluorspar in Thailand other than current economic conditions. Transportation of product to market is commonly provided by either truck or barge. Infrastructure is provided by the numerous small villages located in close proximity to the mines or mills.

China

The seven fluorspar operations examined in China are located in the eastern part of the country. Two are located in Inner Mongolia Autonomous Region, two in Shandong Province, and one each in Jiangxi, Hubei, and Zheijiang Provinces. In the Inner Mongolia autonomous region as well as the other provinces, the administration of the mines and mills is provided by the local branch of the Ministry of Metallurgical Industry, with operating responsibility usually lodged with District Industrial Bureaus.

At all of the mines visited, the ore is hand-cobbed to produce metallurgical grades. Resulting broken pieces, too low in grade for metallurgical grade products are used as feed to flotation mills to make acid grade concentrate. Metallurgical grades are customarily divided in 5 percent increments, ranging from 65 to 95 percent. In some cases, a 98 percent CaF_2 hand-cobbed acid grade lump is produced. The most common metallurgical grade is 80 to 85 percent CaF_2.

None of the operations visited has any post mine processing, beyond making metallurgical grades by hand-cobbing and producing acid grade concentrates by flotation. Furthermore, fluorspar is the only product marketed. There are no by-products or co-products at any of these operations based on the fluorspar ores. Two of the mills had been converted to fluorspar flotation from copper in the case of Fu Shan, and from iron at Xian Shan mill.

This conversion of existing mills and the recent mill construction and expansions to increase acid grade production capability are indicative of a thrust by China to expand its fluorspar exports beyond Japan, which has been its traditional outlet. As a result of the recently increased production capability, sales of acid grade are being promoted in Australia, India, North Korea and the United States. China is also strongly expanding its exports of metallurgical grades to those countries while continuing its supply to the Soviet Union, particularly overland from the mines in Inner Mongolia. China's progressive sales policy is reflected in its willingness to meet any competition in its newly developing markets.

Particularly impressive are China's modern port facilities, including the ports at Dalian (Luda), Tianjin, Qinhuangdao, Yantai and Shanghai, all of which handle significant quantities of fluorspar exports. Smaller amounts move through Ningbo and Guangzhou (Canton). In all, China has 11 first-class harbors available for exports.

In addition to its exports, China is adequately covering its internal needs for fluorspar in its steel, aluminum, fluorocarbon and ceramics industries.

Trucking, rail and river transportation are used for delivery to domestic consumers or to ports for export. In general, infrastructure specifically for the mines and mills is simple and reliance is placed on existing local facilities.

In overall perspective, China emerges as a major factor in world fluorspar. It has large reserves located in the populous provinces with ample infrastructure already in place. Its mines appear to be well managed, producing regularly and operating smoothly, 300 plus days per year. The miners appear to know their jobs and to carry them out effectively. Engineering in the mines and in the flotation mills is comparable to other world-scale producers.

The large pool of manpower makes hand-cobbing of the crude ore a feasible means or producing metallurgical grades. So-called broken pieces, derived from the hand-cobbing, too low grade to be sold for metallurgical uses, are utilized as mill feed, along with run-of-mine crude ore, to produce acid grade.

The acid grade mills are well run. The mill operators appear to be well trained. The product frequently exceeds the 97 percent CaF_2 minimum by a percent or more, insuring its acceptance in world markets. Japan, which is China's principal customer, will accept 96 percent, but will pay a premium for the higher quality. This gives the Chinese incentive to make the higher grade, both for Japan and other acid grade markets where it also commands a premium.

Deleterious elements, such as sulfide sulfur, arsenic, beryllium, and phosphorus, tend to be low, making the Chinese acid grade fully acceptable for the manufacture of hydrofluoric acid which is the precursor for fluorocarbons and aluminum fluorides.

China today is reminiscent of Mexico's situation in fluorspar about 30 years ago, when it began to emerge as a world-scale producer. Both countries have a large labor pool and large reserves. Mexico, however, took a decade or more to develop its flotation capability, while China is moving more rapidly in that regard. Given the increasingly favorable internal incentives for production and enterprise, China will become a reliable, sought-after supplier to the world.

The abundance of China's fluorspar resources, together with the impetus supplied by the authorities to promote their development, makes China fully self-sufficient for its own aluminum, steel and fluorocarbon industries' requirements, as well as allowing it to expand its exports.

Morocco

The El Hammam Mine in Morocco is an acid grade concentrate producer. The operation is one-third owned by a branch of the Moroccan government and is producing strictly for export through the port of Casablanca. The principal consumers of Moroccan fluorspar are Canada and the U.S. Others include Norway and the Federal Republic of Germany.

Infrastructure including a small town, access road, and power line were built by SAMINE, the mine operator.

Due to current market conditions, production has been reduced by approximately 25 percent. However, no further constraints to development were noted.

Tunisia

The Hammam Zriba Mine in Tunisia is an acid grade concentrate producer. This mine is a captive producer for Industries Chimiques du Fluor (ICF) which is a 50 percent owner and the only consumer. Fluorspar product is trucked and then railed to ICF's AlF_3 plant at Gabes. Since the operation began in 1976, it has seen a steady increase in production and is maintaining production levels near capacity.

Possibilities exist for the future recovery of by-products that are currently disposed of in tailings. These include barite and possibly a bulk lead-zinc concentrate.

Italy

Three Italian fluorspar deposits were studied. Two deposits are located on the island of Sardinia and one is located near Rome. One of the Sardinian deposits, Mineria Silius, Sp.A., is currently in operation and the other two are undeveloped resources. Mineria Silius currently produces metallurgical and acid grade concentrates as well as by-products of lead concentrate, and two barite concentrates. Pianciano may potentially produce metallurgical briquettes and Domusnovas may produce acid grade concentrate.

The existing fluorspar industry in Italy is principally for export to the U.S., Europe, Japan, and the USSR. The port of Cagliari on Sardinia provides facilities for direct export of both fluorspar products and other by-products.

The two undeveloped resources of Italy are both in a position to be developed once economic conditions improve. Pianciano has been undergoing geologic and economic feasibility studies for several years. Small-scale operations are currently active and have established much of the infrastructural requirements. The Domusnovas Deposit is in an abandoned iron mining area and could initiate operations by utilizing existing open pits and other near-surface deposits. Both of these resources have had metallurgical test work performed and should be looked upon favorably when the market improves.

Spain

Spanish fluorspar operations were severely depressed at the time of this study. Only two of the four operations were open for site visits. At the other two, management staffs were interviewed. Those mines still operating in Spain have reduced production to meet reduced demand.

Fluorspar mining was active in Asturias Province along the northern coast of Spain. The open pit mines of the past decade are now approaching economic limits; however, extensive underground resources have been identified to maintain production capacities.

The Asturias operations produce acid grade and metallurgical grade concentrates. The acid grade is generally exported while the metallurgical grade is consumed domestically. The port of Aviles on the north coast of Spain is the destination of the Asturias District exports.

Near Granada, in southern Spain, are the Minas de Orgiva operations. A lead concentrate by-product is produced here and consumed by one of the partners, Pennaroya. Acid grade product is exported through the port of Motril on the Mediterranean coast. Consumers are located in the U.S. and Europe.

Economic constraints have recently closed several operations in Spain. Those that remain have reduced production somewhat and become more efficient. The fluorspar districts are long-standing mining areas with well-developed infrastructure and transportation facilities. The future resources are predominantly extensions of existing deposits and will therefore require minimal capital investment to develop. Spain will be in a good position to regain the status of Europe's largest producer when market conditions improve.

South Africa

South African fluorspar operations are centered in the western and northern parts of Transvaal Province. Four active operations and two undeveloped resources were studied. The mining operations are very well serviced by utility and transportation facilities. Railroad facilities link the mines with the port of Durban where products are exported.

Current operators have reduced capacities in view of market conditions; however, South Africa was able to overtake Mexico as the primary supplier of acid grade to the U.S. in 1982. Other consumers of acid grade concentrate include Japan, Canada, and Europe. Domestic consumption of acid grade was also noted. Metallurgical concentrates are produced at the Buffalo Mine of General Mining and are also shipped to the port of Durban.

South Africa has established itself as one of the largest fluorspar producing countries in the world and has demonstrated resources for continued supply well into the future. Two additional undeveloped deposits await economic revival and could have a significant impact on the world supply.

France

The six fluorspar mines and deposits in France are scattered over the southern half of the country. Five active mines and one undeveloped resource were studied. Most of the operations are captive mines and only one produces acid grade for export. Overall, metallurgical gravel, acid grade concentrate, and ceramic grade are produced in France. Most of the operations had reduced capacities at the time of this study.

The destination of French fluorspar is to domestic steel mills, chemical industries, and hydrofluoric acid plants. One producer exports to the Federal Republic of Germany. Transportation is provided by either truck or rail, depending upon distances. For comparison with other exporting countries, the ports of Bordeau and Vendres were used as hypothetical destinations in case of export to North America or the Mediterranean region.

A lead-barite by-product is produced by Rossignol. It also is consumed domestically for making heavy concrete products.

The fluorspar industry of France has reduced capacity in response to reduced markets, as have most other producers. One-half of the deposits studied may be depleted within the next ten years. However, the Morvan District holds a vast resource of fluorspar. Several near-surface deposits have been delineated and tested metallurgically. The main obstacle to development is that the land is currently used for agricultural purposes. The surface owners are very concerned that any mining operations be required to restore the land to its original usefulness as an agricultural base. There are cost-effective methods to achieve this goal, so it is not expected to prohibit mining development in the future.

United Kingdom

The U.K. fluorspar industry is located in two general areas; the Northern Pennines and the Southern Pennines. The operations in these areas have been consolidated so that one company controls the operations in each respective area. The Northern Pennines are controlled and operated by Minworth Industries, Ltd., and the Southern Pennines are controlled and operated by LaPorte Industries.

U.K. fluorspar operations produce both acid and metallurgical grade concentrates. In addition, several by-products are generated including barite concentrates of varying grade, lead concentrates, and aggregate.

One fluorspar mill in the southern orefield is completely idle and three others are operating at reduced capacity. Production in the U.K. is predominantly consumed domestically by steel and chemical industries. Barite products are shipped to North Sea drilling operations and lead concentrates to the continent for smelting. By-products have a considerable effect on project economics here.

Infrastructure is very well developed in the U.K. Truck and railroad transportation facilities are utilized for product delivery. The ports of Newcastle and Kingston provide direct shipment to the North Sea and the Continent, respectively. The U.K. is a net importer of fluorspar and can generally maintain reasonable levels of production domestically despite world market conditions.

There are some environmental concerns to be dealt with since some operations are located in national parks and historical districts. Construction of facilities must result in buildings resembling 18th Century stone or block type. Visual barriers are also required in some instances.

Kenya

The fluorspar production of Kenya originates at a deposit in the Kerio Valley about 130 km northwest of Nairobi. A flotation mill produces acid grade concentrate for export to Asian consumers. This deposit is government-owned and operated.

Production levels have been maintained since 1980 in spite of market fluctuations. In comparison with South African fluorspar, this has a higher phosphorus content and must provide incentives to consumers to buy their product. Truck and railroad facilities are used to transport the product to its destination, Mombasa, on the coast of the Indian Ocean.

Personnel housing facilities and amenities were constructed specifically for the project because of its remote location. Other facilities such as access roads and utilities were extended from those closest to the property.

Even in difficult economic times, this mine continues to maintain production levels and export concentrates. There appear to be no major constraints to continued exploitation of this resource.

Namibia

The Okorusu fluorspar deposit in Namibia is an undeveloped resource with potential for development when economic conditions improve. A very limited amount of material has been extracted and facilities are essentially non-existent. Several different companies have owned this property and evaluated its potential. Test work has included drilling, surface trenching and test pits, and has established tonnage and grade figures and bulk samples for metallurgical testing.

A flotation process will probably be required to generate a metallurgical grade concentrate for export. Briquettes are not considered at present since they do not ship well by sea. The natural market for fluorspar products from Okorusu are Europe and North America, through the port of Walvis Bay. There is direct rail access to within 12 km of the site.

The current constraints to development include the depressed steel industry, the high capital investment requirement for a new mine and mill in a remote area, and the high phosphorus content of the deposit. Competition with the very efficient South African producers will require a very experienced operating and management staff at Okorusu to successfully market the product.

Federal Republic of Germany (FRG)

While FRG is generally considered a consumer rather than a producer of fluorspar, it does have domestic production from the Black Forest area. The operations of Bayer's subsidiary are located at the northern edge, and Sachtleben Bergbau's operations are in the central part near Oberwolfach.

Both operations have flotation mills which generate acid grade concentrates. Most of the concentrates are consumed domestically; however, some is exported to other European destinations. Truck and barge transportation facilities are utilized to get to the destinations of Leverkusen for Bayer, and Kehl on the Rhine River for Sachtleben Bergbau.

Fluorspar could actually be considered a by-product of barite resources at Sachtleben where three barite products are marketed.

Even though FRG is a very large consumer and importer of fluorspar, its domestic operations have felt the effects of world markets and reduced production in response. However, these operations are in a very good position from the standpoint of proximity to market and can therefore sustain production at higher costs and still be competitive with fluorspar coming from Europe and South Africa.

PROJECT EXPERIENCE

Planning

Proper planning was found to be of crucial importance to the project, particularly with respect to the site visits. Although a knowledge of such factors as seasonal weather conditions and national holiday dates were naturally considered before planning the trips, it was also necessary to insure that key operating personnel would be at the property during the course of the visit. In most cases, the key individuals were the general manager, the mine and mill superintendents, and the director of exploration or chief geologist.

Although the general manager usually did not provide any hard data himself, his authorization and initial participation were required in order to obtain the cooperation of the lower level staff members. At times, the required information was obtained from staff engineers or people in the accounting department. In these cases, the cooperation of the appropriate superintendent or department head was required as well.

The blank forms which had been prepared ahead of time proved to be an excellent aid in the data collection process. Although in some cases the operations personnel could, or would, not provide all of the data requested, the field investigator had the assurance that no items were being overlooked.

Personal Contact

The need for key personnel contact was noted early in the project. It was not necessary that the field investigator personally know high level officials in the company being studied, but it was important that the authorization and cooperation begin at or near the top of the organization. In the case of this study, the field investigators themselves were senior level individuals who were acquainted with many officers and representatives of large fluorspar firms or government organizations. In some cases, however, it was necessary to enlist the aid of intermediaries. This was particularly true for Spain and France.

Language

The importance of communicating in the language of the country in question cannot be overstressed. In England, South Africa, Namibia, and Kenya this did not present a problem, inasmuch as English is the predominant business language in those countries. At some mines in other countries key operating personnel spoke English, so in these cases also, there was no problem. At many properties, however, it was necessary to use the services of an assistant or translator who spoke the local language. This was the case particularly for China and France. In certain other countries the investigator himself spoke the foreign language, so no problem arose.

As mentioned earlier, the forms used by the investigator had been translated into the foreign language used at the property being studied. This proved to be a valuable tool since, in some cases, technical staff people at the property would actually fill in parts of the forms themselves.

Data Acquisition Techniques

As described earlier, much of the data were acquired in the field in discussions with the exploration and operating personnel. It was also necessary, however, to make estimates based upon observations made directly by the field investigators. In some instances the most reliable data concerning equipment capacities and quantities and manpower distributions were obtained in this manner.

In a few cases a portion of the data was obtained after the investigator had left the site. The South Africans, Italians, and one English operator were particularly helpful in this respect in that they mailed data to Dames & Moore after the investigator had left the site. The reasons for this varied, being due in some cases to the absence of a key individual at the property at the time of the site visit and in others to the information being kept at some other office.

A technique which proved to be useful in some instances was to follow-up the original site visit with telephone calls. After going through the proper organizational channels, the investigator would talk to the key person who might not have been available at the time of the visit.

Confidentiality

In the highly competitive fluorspar industry, particularly in times of depressed prices, producers are reluctant to part with data which might benefit their competitors. The question of confidentiality was therefore a sensitive issue. It was found that the use of senior personnel in the field was effective in overcoming much of the hesitancy on the part of the mine operators to reveal information about the properties.

SUGGESTIONS FOR IMPROVEMENTS

If improvements can be made to future MAS studies, they should probably be in the area of data collection, particularly cost information. Some suggestions for obtaining more complete data are offered below.

Reciprocity

One of the questions frequently asked of the Dames & Moore representatives was whether or not the cooperating firm would receive any sort of report after the study was completed. Although it was explained that the Bureau of Mines Information Circular would be available, the participating companies and organizations usually indicated that more hard data would be welcome.

Naturally, sensitive technical and cost data could not be made available. A Final Report such as this one, however, with general information regarding the deposits studied might be of interest to the contributing firms. If such a report could be offered, though, it should be made clear to the companies that the report would constitute an overview of the commodity in question with only limited site-specific data.

Confidentiality

During the course of the study it was found that many companies were reluctant to release data because they feared that the information would fall into the hands of competitors. They did not feel that Dames & Moore would reveal the data but rather, that after having been received by the Bureau of Mines it would somehow be made available to the public or to other companies. Dames & Moore was aware, of course, of Public Law 96-479, Section 5(f), which reads as follows:

> "(f) in furtherance of the policies of this Act, the Secretary of the Interior shall collect, evaluate, and analyze information concerning mineral occurrence, production, and use from industry, academia, and Federal and State agencies. Notwithstanding the provisions of section 552 of title 5, United States Code, data and information provided to the Department by persons or firms engaged in any phase of mineral or mineral-material production or large-scale consumption shall not be disclosed outside of the department of the Interior in a nonaggregated form so as to disclose data and information supplied by a single person or firm, unless there is no objection to the disclosure of such data and information by the donor: Provided, however, that the Secretary may disclose nonaggregated data and information to Federal defense agencies, or to the Congress upon official request for appropriate purposes.

Although the language of the section is precise, it might not be entirely clear to a person whose native language is not English. For future foreign MAS projects, therefore, we believe it would be advisable for the Bureau to prepare a more simple statement regarding the confidentiality of the data.