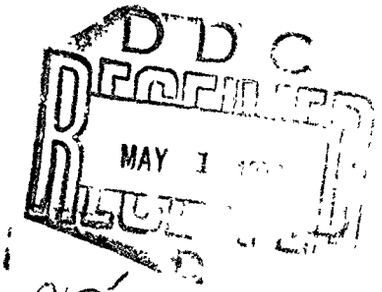
MISCELLANEOUS PAPER NO. 6-719

APPLICATION OF PETROGRAPHY TO RADIATION SHIELDING CONCRETE

by

Katharine Mather

April 1965



U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
Vicksburg, Mississippi

MISCELLANEOUS PAPER NO. 6-719

APPLICATION OF PETROGRAPHY TO RADIATION SHIELDING CONCRETE

by

Katharine Mather

April 1965

U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
Vicksburg, Mississippi

FOREWORD

Subcommittee II-h on Concrete for Radiation Shielding of Committee C-9 on Concrete and Concrete Aggregates of the American Society for Testing and Materials has proposed the holding of a symposium in the area of its interest. Mrs. Katharine Mather, Chief, Petrography and X-ray Section, Engineering Sciences Branch, Concrete Division, U. S. Army Engineer Waterways Experiment Station (WES), a member of Subcommittee II-h, has been asked to contribute a paper to this symposium covering the petrographic aspects of concrete for radiation shielding.

The American Nuclear Society (ANS), in planning for its June 1965 meeting, approached Subcommittee II-h with the request that some of the papers being developed for the II-h symposium be presented at the ANS meeting. One paper so selected was the contribution by Mrs. Mather. The ANS does not plan to publish the papers but does plan to publish summaries. The paper has not been prepared in final form.

This summary was approved for presentation and publication by the Office, Chief of Engineers, by first indorsement dated 7 April 1965 to a letter dated 26 March 1965, subject, "Approval of Paper for Presentation and Approval of Summary for Publication." The summary was prepared by Mrs. Mather under the supervision of Mr. Bryant Mather and Mr. Thomas B. Kennedy, Concrete Division, WES. Col. John R. Oswalt, Jr., CE, was Director of the WES during the preparation of this summary. Mr. J. B. Tiffany was Technical Director.

Application of Petrography to Radiation Shielding Concrete*

Katharine Mather**

In the past twenty-five years, concrete technology has made increasing use of the skills of petrographers and geologists in routine and research investigations of concrete materials -- aggregates, cement-replacement materials, and cement -- and in investigations of field and laboratory concrete. Engineers concerned with the design of radiation shields and the production of shielding concrete may find advantages in making use of geologic and petrographic services in their specialized region of concrete technology.

The services offered by a geologist or petrographer to the technology of shielding concrete include:

Petrographic examination of aggregates

In normal concrete construction, petrographic examination of aggregates proposed for use offers the opportunity to detect some physically undesirable materials not pinpointed by standard physical tests, and offers a quick and relatively inexpensive means of identifying substances capable of reaction with alkalies in portland cement or with tricalcium aluminate in portland cement. Both kinds of reaction produce expansion and cracking; both can be avoided by selection of aggregate-cement combinations that will produce nonexpansive concretes.

---

*Sponsor _____

**Geologist, Concrete Division, U. S. Army Engineer Waterways Experiment Station, Jackson, Mississippi.

The high-density aggregates and aggregates containing water that are used in shielding concrete present special problems, but still problems in which petrographic identification of reactive substances or substances likely to produce problems in concrete production and placement can be useful. Dry-processed barite and dry-processed borates frequently contain clays; limonite ores may contain clays and are also likely to be friable so that they may be expected to produce considerable amounts of fines during conventional concrete mixing. Either situation will raise the amount of water needed for constant workability, and the consequences will include more segregation and bleeding of the placed concrete, lower strength, and increased tendency to crack, as well as lower unit weight. Most of the problems arising from clay or tendency to grind in the mixer could be solved by modifications in processing the aggregates or in the mixing and placement. Barite may be associated with anhydrite or gypsum; either gypsum or anhydrite in excessive amount can produce false set (plaster set) in freshly mixed concrete, or can react after the concrete is in place with tricalcium in cement to cause expansion and cracking, destroying the integrity of a shield and requiring increased maintenance.

ASTM Designation: C 295, Petrographic Examination of Aggregates for Concrete, applies to aggregate for shielding concrete as well as it does to other aggregates. Special aggregates for shielding concrete are selected to have high specific gravity, or to have high fixed water content, or to have both characteristics to the degree that both are obtainable; nevertheless, they are still rocks and minerals from which it is desired to produce concrete which should be particularly well

proportioned, well controlled, and well consolidated if it is to perform as intended. Many concrete shields are not expected to be exposed to weather and, therefore, consideration of resistance to freezing and thawing do not apply. It also appears unlikely that concrete shields need to be constructed to resist aggressive waters of the types to which some concrete structures are exposed. Thermal properties are important and resistance to elevated temperatures is desired.

Use of boron-containing admixtures raises problems in the United States because the naturally occurring borates available are soluble, and borate solutions are strong retarders of portland cement. The solubility rates of different boron minerals will affect the choice of boron-containing admixtures when a choice is available.