



Designation: C 638 – 92 (Reapproved 1997)

Standard Descriptive Nomenclature of Constituents of Aggregates for Radiation-Shielding Concrete¹

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1. Scope

1.1 This nomenclature is intended to give accurate descriptions of some common or important naturally occurring and synthetic constituents of aggregates for radiation-shielding concrete, that, at the same time, are not common or important constituents of concrete aggregates in general use. While most of the minerals and rocks discussed below may occur in small quantities in aggregates in general use, they are not major constituents of such aggregates. Common constituents of aggregates in general use are described in Descriptive Nomenclature C 294. Radiation-shielding concrete often contains such aggregates, but other special aggregates are used in some circumstances.

1.2 The synthetic aggregates included are ferrophosphorus and boron frit.

1.3 The descriptions are not adequate to permit the identification of materials, since accurate identification of natural and synthetic aggregate constituents in many cases can only be made by a qualified geologist, mineralogist, or petrographer, using the apparatus and procedures of those sciences.

2. Referenced Documents

2.1 ASTM Standards:

C 294 Descriptive Nomenclature of Constituents of Natural Mineral Aggregates²

3. Types of Materials

3.1 Two classes of materials are described below. The first class consists of minerals and rocks formed from them, and synthetic materials, that have high specific gravity and in addition contain substantial proportions of atoms of high or moderately high atomic weight. They are referred to as heavy or high-density aggregates. The second class consists of minerals and synthetic glasses of substantial boron content that are particularly effective in absorbing thermal neutrons without producing highly penetrating gamma rays. The boron-frit glasses are included because of their frequent use.

HEAVY AGGREGATES

4. Descriptions of Naturally Occurring Constituents

4.1 Members of this group have higher specific gravities than aggregates in general use. Six are iron minerals, of which five are important iron ore minerals and the sixth is an ore of titanium. Two are barium minerals worked as the principal sources of barium salts. The other is ferrophosphorus, a mixture of synthetic iron phosphides.

4.2 The constituents are described below first as minerals, and then as major constituents of ores when their aspect as major constituents of ores affects the behavior of ores as concrete aggregates.

5. Iron Minerals and Ores

5.1 *Hematite* (Fe_2O_3)—Hematite has a hardness of 5 to 6 on Mohs' scale (will be scratched by hard steel), and a specific gravity of 5.26 when pure. The color varies from bright red to dull red to steel gray; luster varies from metallic to submetallic to dull; the streak is cherry red or reddish brown; it is nonmagnetic.

5.1.1 *Hematite Ores*—Rocks of which hematite is the major constituent vary from one deposit to another, and within the deposit, in specific gravity, toughness, compactness, amount of impurities, degree of weathering, and suitability for use as concrete aggregate. Hematite appears to be the iron ore mineral most exploited as a source of iron. The ores of the Lake Superior region are banded sedimentary ores consisting of layers rich in hematite, and sometimes goethite, iron silicates, such as stilpnomelane, minnesotaite, greenalite, grunerite, and iron carbonate, alternating with silica-rich layers of chert or fine-grained quartz or a mixture. The Birmingham, AL ores are oolitic with hematite replacements of oölites and fossils in a matrix that ranges from fine-grained earthy hematite, with or without calcite, to crystalline calcite. Hematite ores dust in handling, with the dust ranging in color from moderate red to dusky red to moderate reddish brown (5R 4/6 to 5R 3/4 to 10R 4/6).³

5.2 *Ilmenite* (FeTiO_3 with minor Mg and Mn)—Ilmenite has a hardness of 5 to 6 and specific gravity of 4.72 ± 0.04 when pure. The color is iron black with metallic to submetallic luster;

¹ This nomenclature is under the jurisdiction of ASTM Committee C-9 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.41 on Concrete for Radiation Shielding.

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² *Annual Book of ASTM Standards*, Vol 04.02.

³ National Research Council, Washington, DC, *Rock Color Chart* (1948) reissued 1964 by Geological Soc. Am., New York, NY.