Excerpts from **"Industrial Minerals and Rocks – 6th Edition"**
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Library of Congress Catalog Card Number 93-84488

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GARNET

" Garnet is the general name for a family of complex silicate minerals having similar physical properties and crystallizing in the isometric (cubic) system. All garnets have the same general chemical formula but vary greatly in chemical composition."

"Mineralogy
Chemical Properties: The general formula for garnet is $A_3B_2(SiO_4)_3$, where A can be calcium, magnesium, ferrous iron, or manganese, and B can be aluminum, ferric iron, or chromium, or rarely titanium. The formulas and names of common garnet species are:

Uvarovite:	$Ca_3Cr_2Si_3O_{12}$
Grossularite:	$Ca_3Al_2Si_3O_{12}$
Andradite:	$Ca_3Fe_2Si_3O_{12}$
Pyrope:	$Mg_3Al_2Si_3O_{12}$
Almandite:	$Fe_3Al_2Si_3O_{12}$
Spessartite:	$Mn_3Al_2Si_3O_{12}$

Almandite and almandite-pyrope solid solution garnets are the best abrasive types, but andradite, grossularite, and pyrope also are used."

"The structure of garnet consists essentially of isolated SiO4 tetrahedra connected by oxygen-cation-oxygen bonds through the distinct A and B group cation sites. Within this structure magnesium, ferrous iron, and manganese easily interchange and substitute for each other in the A cation position, and calcium does so less readily. Additionally, aluminum, ferric iron, and chromium substitute for each other to a limited extent in the B cation position."

"This ability to substitute or exchange ions without changing the crystal structure is called isomorphism, and garnet is one of the finest examples of a isomorphous series."

"**Physical Properties:** Garnet displays the greatest variety of color of any industrial mineral. Garnets have been found in all colors except blue. For example, grossularite can be colorless, white, gray, yellow, yellowish-green, various shades of green, brown pink, reddish or black. Andradite garnet can be yellow-green, green, greenish-brown, orangy-yellow, brown, grayish-black, or black. Pyrope is commonly purplish red, pinkish-red, orangy-red, crimson, or dark red; and almandite is deep red, brownish-red, brownish-black, or violet-red."

"Because of the great variation in color of garnet within each species and similarities in color between garnets of different species it is recommended that garnet identification not be based on color alone."

" The Mohs hardness of garnet varies from 6.5 to 9.0. Grossularite and uvarovite have a hardness of 6.5 to 7.5; andradite is 6.5 to 7.0; and pyrope, almandite, and spessartite are 7.0 to 7.5 in hardness. There are reports of almandite having a hardness of between 8.0 and 9.0."

"As with hardness, the specific gravity of garnet varies considerably. The specific gravity may be as low as 3.2 or as high as 4.3 depending on chemical composition."

"Garnet crystallizes in the isometric system with rhombic dodecahedra and trapezohedra the most common forms.... Garnet also forms as irregular blebs, grains, knots, or masses, with or without distinguishable crystal faces, and as coarse- or fine- grained granular masses that appear to be totally lacking in crystal form."

"The fracture of garnet also shows great variation. In some garnets, particularly those that are well crystallized and glassy in appearance, the fracture is sub-conchoidal to conchoidal. Other, more poorly crystallized garnets exhibit a fracture that can only be described as uneven."

"Tenacity, the resistance of a mineral to break, crush, bend or tear, is a function of its hardness, structure, and chemical composition. Because of variations between different species of garnet and within the same species the tenacity of garnet is not consistent... Aggregates of garnet that are comprised of small, individual, irregular blebs, grains, or masses are brittle and break or crush readily. In comparison, garnet formed as coarse- or fine- grained granular masses or well-formed crystals is very tough and shatters with difficulty. Also, certain species of garnet are more brittle than others. Almandite and pyrope tend to be less brittle than other species."

"In many instances andradite has not proved satisfactory for use as an air-blasting medium or in other abrasive applications."

"**Quality of the Garnet:** The garnet in a deposit must be tested to evaluate its performance and marketability as an abrasive. It should be recognized in this regard that most garnet used in abrasive applications is either the almandite or almandite-pyrope type. The garnet should be present in the deposit as discrete crystals that are at least 6-13 mm in size and that are liberated when the ore is crushed to -2 mm. The crystals should be free of any inclusions, such as quartz, mica, hornblende and feldspar, and also should be free of alteration. The garnet should be relatively uniform in hardness and density throughout the deposit. It should not be badly weathered or highly friable."