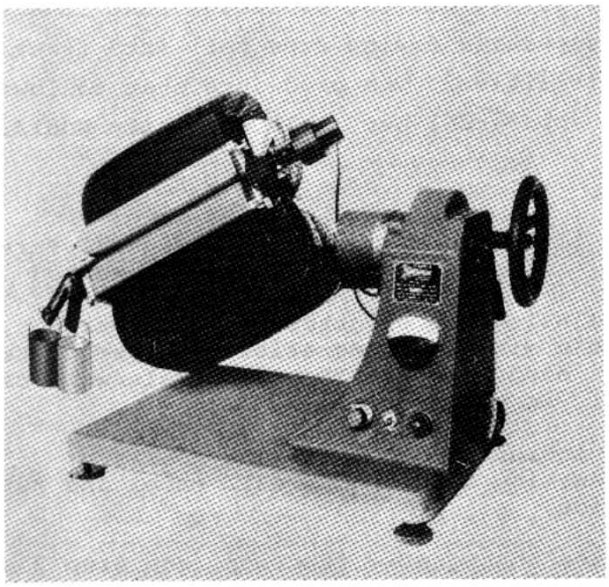
Separating Minerals on the Basis of Their Magnetic Properties

The Frantz Isodynamic Magnetic Separator

Magnetic separation of mineral particles depends on the magnetic susceptibility of the minerals to be separated. This is a complex phenomenon which is a function of chemical composition, especially minor amounts of iron or manganese, and atomic-lattice structure.

The simplest form of magnetic separation is by hand magnet, a procedure which works for only one common detrital mineral - magnetite. Other minerals having magnetic susceptibility are separated by using apparatus which generate strong electromagnetic fields. Companies which market electromagnetic separators suitable for mineralogic work are: S. G. Frantz Co., Trenton, New Jersey; Chas. W. Cook & Sons, Ltd., Birmingham, England; and R. Eisenblaetter, Lingolsheim (Bas-Rhin), France.

The Frantz separator (Fig. 5-3) incorporates an electromagnet with two elongate pole pieces arranged so that the space between the poles is much wider on one side than the other. A vibrating metal chute parallels the pole pieces. Mineral particles are introduced into the upper end of the chute and slide toward the lower end. Those with higher magnetic susceptibility move toward the side of the chute where the pole gap is



Frantz Isodynamic Magnetic Separator
(inclined position)
(Müller, 1967)

Figure 5-3

narrow and the magnetic flux the greatest. The separator is mounted so that it can be rotated both in the direction of grain movement (slope) and in a direction normal to the direction of grain movement (tilt). The way in which mineral particles separate as they move along the length of the chute depends on (1) the tilt of the chute, (2) the amperage applied to the electromagnet and, to some extent, (3) the slope and rate of feed to the chute. At the lower end of the chute the particles are separated into two streams, one consisting of grains of higher susceptibility than that corresponding to the amperage setting used, the other consisting of grains of lower susceptibility.

Inasmuch as there is wide variation in magnetic susceptibility of mineral particles of a given species, it is common practice to set the Frantz separator slope at 10 to 30° (20° is more or less standard), the tilt at 5 to 20° (5° for minerals of low susceptibility, 15° for those of moderate to high susceptibility) and then determine the most effective amperage by trial and error.

The magnetic separator manufactured by Chas. W. Cook & Sons is very similar to the Frantz separator; the Eisenblaetter separator, developed in the early 1960s, has the advantage that in a single operation sample material is separated during free fall into fractions having different mass susceptibilities. The procedure that follows is designed for use with the Frantz apparatus, but could be easily modified for use with the Cook separator.

Procedure II: Separation of Heavy-Mineral Particles by the Magnetic-Susceptibility Method

1. Before using the electromagnetic separator, remove ferromagnetic minerals (magnetite and pyrrhotite) from the sample with a hand magnet. These minerals will clog the apparatus if left in the sample.

2. Using a side slope of 20° and a tilt of 25°, run the sample at a setting of 0.4 amperes. Label and retain the magnetic fraction.

3. Take the nonmagnetic fraction from Step 2 and run it at a setting of 0.8 amperes. Label and retain the magnetic fraction.

4. Take the nonmagnetic fraction from Step 3 and run it at a setting of 1.5 amperes. Label and retain the magnetic fraction and the nonmagnetic fraction.

5. Refer to Table 5-2 for a listing of those heavy minerals which are magnetic at 0.4, 0.8, and 1.5 amperes.

Magnetic at 0.4	Magnetic at 0.8	Magnetic at 1.5	Nonmagnetic at 1.5
Garnet	Biotite	Muscovite	Zircon
Ilmenite	Hornblende	Spinel	Rutile
Chromite	Hypersthene	Enstatite	Sphene
Chloritoid	Augite	Tourmaline	Leucoxene
Olivine	Actinolite	Clinozoisite	Apatite
	Staurolite	Diopside	Corundum
	Epidote	Tremolite	Barite
	Chlorite		Fluorite
			Sillimanite
			Kyanite

Minerals which are magentic at 0.4, 0.8, and 1.5 amperes settings (side slope 20°, tilt 25°) on the Frantz Isodynamic Magnetic Separator