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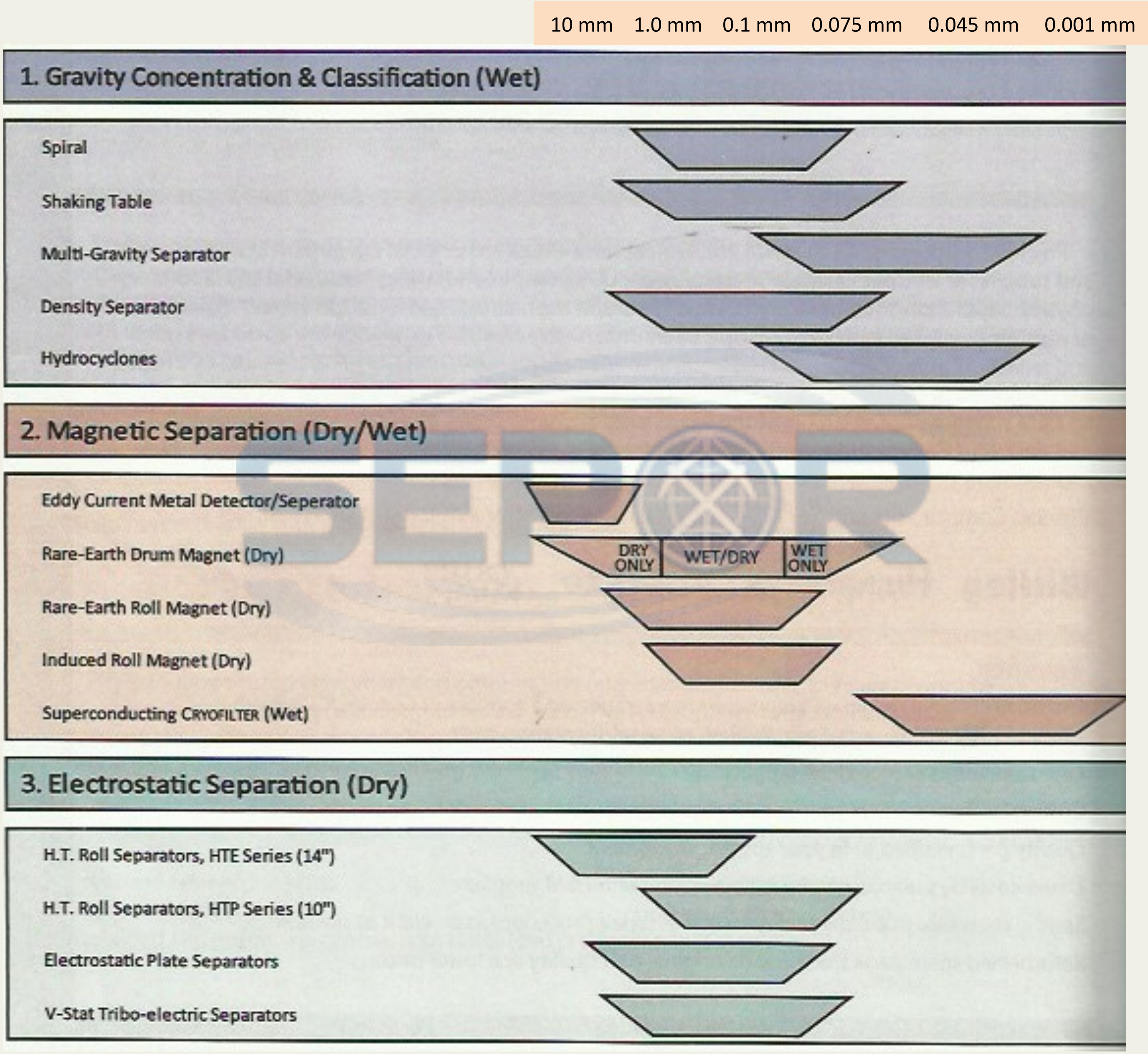
Magnetic & Electrostatic Separation Concentration Method vs Size Range



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Magnetic & Electrostatic Separation Response Chart

Physical Characteristics of Select Minerals and Materials			Magnetic Response			Electrostatic Response	
Mineral	Composition	Specific Gravity	F	P	NM	C	NC
Actinolite	$Ca_2(Mg,Fe)5[Si_4O_{11}]_2(OH)_2$	3.0-3.2		X			X
Albite	$Na[AlSi_3O_8]$	2.6			X		X
Almandine	$Fe_3Al_2[SiO_4]_3$	4.3		X			X
Amphibole	$(Fe,Mg,Ca)_xSiO_3$	2.9-3.5		X			X
Anatase	TiO_2	3.9			X	X	
Andalusite	Al_2SiO_5	3.2			X		X
Andradite	$3CaO•Fe_2O_3•3SiO_2$	3.8		X		(2)	X
Anhydrite	$CaSO_4$	3			X		X
Ankerite	$Ca(Mg,Fe)[Co_3]_2$	2.9-3.1		X			X
Apatite	$(F,Cl,OH)Ca_5(PO_4)_3$	3.2			X		X
Aragonite	$CaCO_3$	3			X		X
Arsenopyrite	FeAsS	5.9-6.2		X →	(1)	X	
Asbestos	$Mg_3[Si_2O_5](OH)_4$	2.4-2.5			X		X
Augite	$Ca(Mg,Fe,Al)[(Si,Al_2)O_6]$	3.2-3.5		X		X	(1)
Azurite	$Cu_3[CO_3]_2(OH)_2$	3.8			X		X
Baddeleyite	ZrO_2	5.6			X		X
Barite	$BaSO_4$	4.5			X		X
Bastnaesite	$(Ce,La,F)CO_3$	5		X			X
Bauxite	$Al_2O_3•2H_2O$	2.6			X		X
Beryl	$Be_3Al_2[Si_6O_{18}]$	2.7-2.8			X		X
Biotite	$K(Mg,Fe)_3[Si_3AlO_{10}](OH,F)_2$	3.0-3.1		X			(4)
Bismuth	Bi	9.8			X	X	
Borax	$Na_2B_4O_7•10H_2O$	1.7			X		X
Bomite	Cu_5FeS_4	4.9-5.0		(1) ←	X	X	
Brannerite	$(UO,TiO,UO_2)TiO_3$	4.5-5.4		X		X	
Brookite	TiO_2	4.1			X	X	
Calcite	$CaCO_3$	2.7			X		X
Camotite	$K_2(UO_2)_2V_2O_8•2H_2O$	5			X	(2)	X
Cassiterite	SnO_2	7			X	X	
Celestite	$SrSO_4$	4			X		X
Cerussite	$PbCO_3$	6.6			X	(2)	X
Chalcocite	Cu_2S	5.5-5.8			X	X	
Chalcopyrite	$CuFeS_2$	4.1-4.3		(1) ←	X	X	
Chlorite	$(Mg,Al,Fe)_{12}[(Si,Al)_8O_{20}](OH)_{16}$	2.6-3.2		X			X
Chromite	$(Fe,Mg)(Cr,Al)_2O_4$	4.6		X		X	
Chrysocolla	$CuSiO_3•2H_2O$	2.0-2.3			X		X
Cinnabar	HgS	8.1			X		X
Cobalitite	(Co,Fe)AsS	6.0-6.3		X		X	
Colemanite	$Ca_2B_6O_{11}•5H_2O$	2.4			X		X
Collpohanite	$Ca_3P_2O_8•H_2O$	2.6-2.9			X		(3)
Columbite	$(Fe,Mn)(Ta,Nb)_2O_6$	5.2-8.2		X		X	
Copper	Cu	8.9			X	X	
Corundum	Al_2O_3	3.9-4.1			X		X
Covellite	CuS	4.7			X	X	
Crypolite	Na_3AlF_6	3			X	(2)	X
Cuprite	Cu_2O	5.8-6.2			X		X
Diamond (natural)	C	3.5			X		X
Diamond (synthetic)	C	3.5		X			X
Diopside	$CaMg[Si_2O_6]$	3.3-3.4		X →	(1)		X
Dolomite	$CaMg(CO_3)_2$	1.8-2.9			X		X

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Mineral	Composition	Specific Gravity	F	P	NM	C	NC
Epidote	$Ca_2(AlFe)_3Si_3O_{12}(OH)$	3.4		X			X
Euxenite	$(Y,Er,Ce,La,U)(Nb,Ti,Ta)_2$	4.7-5.2		X		X	
Feldspar Group	$(K,Na,Ca..)_x(Al,Si)_4O_8$	2.6-2.8			X		X
Ferberite	$FeWO_4$	7.5	(1) ←	X		X	
Flint	SiO_2	2.6			X		X
Flourite	CaF_2	3.2			X		X
Franklinite	$(Zn,Mn)Fe_2O_4$	5.1-5.2	X			X	
Gahnite	$ZnAl_2O_4$	4.6			X		X
Galena	PbS	7.5			X	X	
Garnet	Complex Ca,Mg,Fe,Mn Silicates	3.4-4.3		X →	(1)	(2)	X
Gibbsite	$Al(OH)_3$	2.4			X		X
Geothite	$HFeO_2$	4.3		X		(2)	X
Gold	Au	15.6-19.3			X	X	
Graphite	C	2.1-2.2			X	X	
Grossularite	$Ca_3Al_2(SiO_4)_3$	3.5			X	(2)	X
Gypsum	$CaSO_4 \cdot 2H_2O$	2.3			X		X
Halite	NaCl	2.5			X	(2)	X
Hematite	Fe_2O_3	5.2		X		X	
Hornblende	$Ca_2Na(Mg,Fe^{+2})_4(Al,Fe^{+3})$	3.1-3.3		X		(2)	X
Huebnerite	$MnWO_4$	6.7-7.5		X →	(1)	X	
Hypersthene	$(Mg,Fe)SiO_3$	3.4		X			X
Ilmenite	$FeTiO_3$	4.7		X		X	
Ilmenorutile	$(Nb_2O5,Ta_2O_5)_xTiO_2$	5.1		X		X	
Ilvaite	$CaFe_2(FeOH)(SiO_4)_2$	4		X		X	(1)
Kaolinite	$Al_2Si_2O_5(OH)_4$	2.6			X		X
Kyanite	$Al_2O[SiO_4]$	3.6-3.7			X		X
Lepidolite	$(OH,F)_2KLiAl_2Si_3O_{10}$	2.8-2.9			X		X
Leucoxene	$FeTiO_3$ → TiO_2 (Alteration Product)	3.6-4.3		X →	(1)	X	
Limonite	$HFeO_2 \cdot nH_2O$	2.2-2.4		X →	(1)	(2)	X
Magnesite	$MgCO_3$	3			X		X
Magnetite	Fe_3O_4	5.2	X			X	
Malachite	$Cu_2CO_3(OH)_2$	4			X		X
Manganite	MnO(OH)	4.3		X →	(1)	X	
Marcasite	FeS_2	4.6-4.9		(1) ←	X	X	
Martite	(See Hematite)	-					
Microline	$KAlSi_3O_8$	2.6			X		X
Microlite	$Ca_2Ta_2O_7$ (See Pyrochlore)	5.5			X		X
Millerite	NiS	5.2-5.6		X		X	
Molybdenite	MoS_2	4.7-5.0			X	X	
Monazite	$(Ce,La,Y,Th)PO_4$	4.9-5.5		X			X
Mullite	$Al_6Si_2O_{13}$	3.2			X		X
Muscovite	$KA_{12}[AlSi_3O_{10}][F,OH]_2$	2.8-3.0			X		(4)
Nahcolite	$NaHCO_3$	2.2			X		X
Nepheline Syenite	$(Na,K)(AlSi)_2O_4$	2.6			X		X
Niccolite	NiAs	7.6-7.8		X		X	
Olivine	$(Mg,Fe)_2[SiO_4]$	3.3-3.5		X			X
Orpiment	As_2S_3	3.4-3.5			X	X	
Orthoclase	$K[Al,Si_3O_8]$	2.5-2.6			X		X
Periclase	MgO	3.6			X		X
Perovskite	$CaTiO_3$	4			X		X
Petalite	$Li(AlSi_4O_{10})$	2.4			X		X
Phosphate (pebble)	(See Collaphanite)	-					
Platinum	Pt	14.0-21.5		(1) ←	X	X	
Pyrite	FeS_2	5		(1) ←	X	X	
Pyrochlore	$(Na,Ca..)_2(Nb,Ta..)_2O_6(F,OH)$	4.2-4.4			X	X	
Pyrolusite	MnO_2	4.7-5.0		(1) ←	X		X
Pyrope	$Mg_3Al_2(SiO_4)_3$	3.5			X	(2) ←	X
Pyroxene	$(Ca,Mg,Fe,Al)_2Si_2O_6$	3.1-3.6		X →	(1)	(2) ←	X
Pyrrhotite	$Fe_{x-1}S_x$	4.6-4.7	X			X	

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Mineral	Composition	Specific Gravity	F	P	NM	C	NC
Quartz	SiO_2	2.7			X		(3)
Realgar	AsS	3.6			X	X	
Rhodochrosite	$MnCO_3$	3.7			X	(2) ←	X
Rhodonite	$MnSiO_3$	3.6-3.7			X	(2) ←	X
Rutile	TiO_2	4.2-4.3			X	(2)	
Samarskite	$(Y,Er..)_4[(Nb,Ta)_2O_7]_3$	5.6-5.8	(1) ←	X		X	
Scheelite	$CaWO_4$	6.1			X		X
Serpentine	$Mg_6[Si_4O_{10}](OH)_8$	2.5-2.7		X			X
Siderite	$FeCO_3$	3.9		X		(2) ←	X
Sillmanite	$Al_2O(SiO_4]$	3.2			X		X
Silver	Ag	10.1-11.1			X	X	
Smithsonite	$ZnCO_3$	4.1-4.5			X		X
Sodalite	$Na_8[Al_6Si_6O_{24}]Cl_2$	2.1-2.3			X		X
Spessarite	$Mn_3Al_2(SiO_4)_3$	4.2			X		X
Sphalerite	ZnS	3.9-4.0		X →	(1)	X →	(1)
Sphene	$CaTi[SiO_4](F,OH)$	3.3-3.6			X	(2) ←	X
Spinel	$MgAl_2O_4$	3.6		(1) ←	X	X	(1)
Spodumene	$LiAl(SiO_3)_2$	3.1-3.2			X		X
Stannite	Cu_2FeSnS_4	4.3-4.5			X	X	
Staurolite	$Fe^{+2}Al^{2}[Si^{2}O_{11}]_2O_2(OH)_2$	3.6-3.8		X		(2) ←	X
Stibnite (Antimonite)	Sb_2S_3	4.6			X	X	
Struverite	$(Ta_2O_5,Nb_2O_5)_x TiO_2$	5.1		X		X	
Suplher	S	2.1			X		X
Sylvite	KCl	2			X		X
Talc	$Mg_3Si_4O_{10}(OH)_2$	2.7-2.8			X		X
Tantalite	$(FeMn)(TaNb)_2O_6$	5.2-8.2		X		X	
Tapiolite	$Fe(Ta,Nb)_2O_6$	7.3-7.8		X		X	
Tetrahedrite	$(Cu,Fe)_{12}Sb_4S_{13}$	5		X		X	
Thorianite	ThO_2	9.7			X		X
Thorite	$ThSiO_4$	4.5-5.4			X		X
Topaz	$Al_2SiO_4(F,OH)_2$	3.5-3.6			X		X
Tourmaline	$(Na,Ca)(Mg,Fe^{+2},Fe^{+3},Al,Li)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$	2.9-3.2		X →	(1)	(1,2) ←	X
Uraninite	UO_2	11		X			X
Vermiculite	$Mg_4[Al,Si^{3}O_{10}](OH)_2 \cdot nH_2O$	2.4-2.7			X		X
Wolframite	$(Fe,Mn)WO_4$	6.7-7.5		X		X	
Wollastonite	$CaSiO_4$	2.8-2.9			X		X
Wulfenite	$PbMoO_4$	6.7-7.0			X	X	
Xenotime	YPO_4	4.4-5.1		X			X
Zeolite	Hydrous Alumino-Silicate usually of Ca and Na	2.0-2.5			X		X
Zincite	ZnO	5.7			X	(1)	X
Zircon	$ZrSiO_4$	4.7			X		X

Explanation of Table:

Magnetic response is classified as (1) ferromagnetic: attraction to a conventional permanent magnetic separator at a metric flux density of less than 0.2 Tesla (2,000 gauss), (2) paramagnetic: attraction to the magnetic zone of a high intensity magnetic separator operating at greater than 0.2 to 2.0 Tesla (2,000-20,000 gauss), and (3) non-magnetic or diamagnetic: not-affected or repelled respectively from the magnetic force described in (2). Electrostatic response is classified as conductive or non-conductive based on the surface resistivity a mineral. Generally, minerals with a surface resistivity of less than 10^{11} ohms will report as "conductors" using standardized set ngs on an electrostatic separator. Minerals with a surface resistivity above 10^{12} ohms will report as "non-conductors" under similar equipment set ngs.

Notes: (1) Variations in response to magnetic and electrostatic separation will occur based on the actual composition of the mineral from varying locations and the presence of inclusions, (2) The response of some minerals can be varied be treatment at elevated temperature, i.e. rutile becomes more conductive at temperatures greater than 200 C, (3) Triboelectric (contact) charging can be used to selectively charge certain minerals; and they, in turn, can be attracted to an electrode of the opposite polarity, i.e. quartz from collophanite (pebble phosphate), (4) The separation of particles with a pronounced shape factor (mica) can also be accomplished by the use of a non-uniform electric field (dielectrophoresis).