a13 Classification of sedimentary rocks < settling >

The popularity of the triangle is probably attributable partly to its value for graphic display and partly to motives that only a psychoanalyst could plumb. —Harvey Blatt.[1]

Weathering is the process that changes bedrock to soil

At Earth's surface, rock weathers to soil by physical breakup aided by solution and by the chemical alteration of silicate minerals to clay, water-soluble salts (carbonates of Na, K, Ca, and Mg), insoluble precipitates (hematite, goethite, opal, and wad), and residues (bauxite). Minerals in the source rock, which remain unaltered in the soil, are resistate minerals. These can be chemically stable (as are diamonds, garnet, gold, magnetite, quartz, and rutile) or chemically metastable (as are cassiterite, ilmenite, and sphene). Supportive of life, "soil" enthused Nathaniel Southgate Shaler (1841-1906) "is the realm of mediation between the inorganic and the organic kingdom, [and] it is by the variety of its functions more nearly akin to the vital than to the lifeless part of the earth."[2]

Erosion is the process that removes loose materials from the place of weathering

At Earth's surface, erosion removes from the place of weathering, dissolved salts, colloids, and solid particles (called *clasts*).

A clast (Gk. *klastos* means *broken*) is a fragment of a larger body or a loose solid particle of any size. Crystalline material broken at Earth's surface cannot be put back together again (to anneal). This is because the fracture surfaces are almost immediately coated (oxidized or hydrolyzed). Breakage is a one way process (the Humpty Dumpty tragedy), leading to ever smaller pieces. The process aids chemical weathering by exposing more and more surface area of the broken material to chemical reactions (the reason for a chemists's use of a mortar and pestle).

Clasts that are produced by mechanical weathering originate with an angular shape. Sedimentary clast sizes are (in decreasing size): boulder, cobble, pebble, granule, sand (size range: 2 - 1/16 mm in diameter), silt, and clay-size. During transportation, clasts become progressively sorted according to size, chemically weathered, and rounded from an initially more angular shape. Large, heavy, clasts do not have to travel far to become well rounded. Sand-sized clasts must travel great distances to become well rounded. In all these ways, detrital sediment "matures" during transportation.

Sediments are accumulations of transported materials

Dissolved leachate salts released from the place of weathering, after transportation either in solution or as particulates (as say, salt grains, shells, or plant debris), are deposited as *chemical sediments*. Chemical sediments can originate in three ways: solvent (water) evaporation, chemical precipitation, and biogenic precipitation. Classification of chemical sediments depends firstly on composition (commonly: carbonate, sulfate, chloride, oxide, and hydrocarbon) and secondly on the texture: *nonclastic* crystalline or massive, sometimes oolitic, (micrite, sparite, fossiliferous limestone, travertine, tufa, siliceous sinter, opal, rock gypsum, rock salt, and wad) and biogenic (reef limestone, coquina, chalk, diatomite, amber, peat, lignite, and bituminous coal). The source area from which chemical sediments are derived is traceable rarely and not at all for marine chemical sediments.

Rock fragments and resistate minerals released from the place of weathering, after transportation as *clasts* (which if larger than silt become progressively rounded), are deposited as *detrital sediments*. Classification of detrital sediments depends firstly on texture (the average size of constituent clasts) and secondly on the rock type or mineral compositions of the clasts and what cements or is between them. For example, sandstone (arenite) can be ferruginous-, calcareous-, clayey-, or quartz-sandstone, arkose, or graywacke, and so on. Immature detrital sediments can often be traced to a source area. This is done when prospecting for the "mother load" of valuable placer minerals.

In time, sediments lithify to sedimentary rock

The processes (compaction, cementation, and partial recrystallization involving grain-margin dissolution and replacement) whereby unconsolidated sedimentary rocks (sediments) become consolidated sedimentary rocks (stones of sedimentary origin) at surface or burial conditions that do not involve metamorphic change, are collectively called *lithification* (Gk. *lithos*, stone). Lithification (for which *diagenesis* is a lofty synonym) can be fast (***Footnote a13.1***), or it can take place over, or after, hundreds of millions of years. For the latter reasons, a sedimentary rock's age is how long ago it accumulated as sediments (and its age is not when it became a stone).

Clay lithifies by compaction to shale.
Sand lithifies by cementation to sandstone
Lime mud lithfies by partial recrystallization to limestone

All three of the above mechanisms play some role in the lithification of most sediments. In discussing pressure dissolution features, L. Bruce Railsback elaborates: "Extensive intergranular pressure dissolution reduces intergranular porosity as grains move together. Intergranular pressure dissolution also generates dissolved solids that may be precipitated in nearby pores, occluding porosity [and] eventually precluding further intergranular pressure dissolution. Intergranular pressure dissolution may also stop as the areas of grain contacts expand to provide surfaces sufficient to support the force previously focused on smaller areas as greater stress. In that case, remaining intergranular pore space may be filled by cements precipitating by advecting fluids. If intergranular pressure dissolution proceeds to destroy all pore space with no cementation, so that the rock consists of sutured grains with no intergranular space at all, the resulting texture is a 'fitted fabric.'"[3]

Sediments or sedimentary-rock names (***Figure a13.1***) most simply declare the relative abundances of detrital (sand, silt, or clay), chemical (calcite, or dolomite), and authigenic (opal, quartz, or chalcedony) components.

In the field, stratification of layers and beds is the most evident feature of sedimentary rocks where they crop out in the sides of valleys.

The scientific study of sedimentary and layered-volcanic rocks is called *stratigraphy* (a word that entered the lexicon via William Smith's *Stratigraphical System of Organized Fossils*, 1817).[4] ❑

Footnote a13.1 Concrete is an artificial stone made by mixing gravel with cement and adding water. Portland cement (which proper name refers to a limestone of similar appearance) patented by Joseph Aspdin in 1824 is chalk and mixed-in clay which is dry kiln-baked to clinker and then ground to a powder.[5] With water it crystalizes primarily into four minerals: tricalcium silicate, dicalcium silicate, tricalcium aluminate, and tetracalcium aluminoferrite. Sulfate ions naturally common in water and soil, and in fertilizer, can later penetrate concrete causing it to crack and expand.[6]

Figure a13.1 Names for sediments and sedimentary rock with mixture-ranges of detrital and chemical content.

The detrital grains (sand, silt, or clay) do not include detrital grains of calcite or dolomite.[7]