CHONDRITES AND CHONDRULES ANALOGOUS TO SEDIMENTS. R. K. Herd[1], [1]Curator, National Meteorite Collection of Canada (Retired) herdrk@gmail.com

Summary: Comparing chondrites and terrestrial conglomerates [1] continues.

.

Introduction: Chondrites are rocks made of rocks. They are composed of chondrules and chondrule-like objects: grains of roughly spheroidal pebble-like rocks predominantly composed of olivine, pyroxene, feldspar, iron-nickel minerals, chromite, magnetite, sulphides etc. . They range from nanoscale to more than a centimetre, with some size variation by chondrite type. There are thousands of them available for study. Hundreds of chondrules fill the area of a single 3.5 x 2.5 cm standard thin section. Studies have shown that adjacent chondrules may be millions of years different in age. They date from the time of earliest solar system objects (viz. other rocks, agglomerations of minerals such as CAIs). They contain relict mineral phases from the interstellar medium (ISM): inorganic and, in some cases, organic materials older than our solar system, perhaps older than our galaxy. Each chondrule has witnessed extraterrestrial processes, probably repeatedly; minerals in meteorites, their textures, and the elements which form them, may have been formed and reformed in and around stars reaching back to the origin of the universe. Some researchers have deemed chondritic textures too complex to decipher, and have broadly pigeon-holed them. Textures are destroyed by grinding up the meteorites to analyze their collective isotopes. Or, isotopic studies do not describe chondrule textures.

Methodology: There are no textbooks to assist the documentation and interpretation of chondrite and chondrule textures. Studies over the last decade especially have concentrated on the documentation of intrachondrule and interchondrule textures in grades 3-5 ordinary chondrites using BSE and digital photography.

Results: (1) Recognition that chondrule textures are derived from mineral intergrowths at different grain sizes. Demonstration that the textures of chondrules are polymodal, and that phases contributing e.g. to an overall porphyritic aspect of a chondrule may not be in textural or chemical equilibrium. Chondrule textures document more than single events; melting, heating, cooling, crystallization and reactions have repeatedly occurred. Recognition of 4 relative grain-sizes of material contained in chondrules: mega (M), macro (m), micro (μ), and mesostasis (*ms*); derivation of barcode-like numerical labels for chondrules to associate or distinguish them. Subdivision of major chondrule groups (PO, POP, PP, R etc.) [2,3,4]. **Results: (2)** Realization that all chondritic meteorites record chondrule formation from primitive materials; all chondrules are made from such feedstock, some of which is preserved as relics. Realization that chondrule-forming events are a datum in chondrites, part of a progression; a flow of events, and processing, is implied and likely, after chondrule formation. Subdivision of overall chondrule mineral textures (ω) into those associated with relics (α), derivation by heating/cooling before incorporation into a solid body (β), during formation (β1) and transport prior to incorporation (β2), after incorporation (γ), during (hydrous) weathering (δ), during space weathering (ε) , during fusion crust formation, (π), shock (σ) etc. . Realization that there are analogous natural terrestrial processes , viz. erosion, sedimentation and lithification to those seen in chondrites. [5,6]. **Results: (3)** Realization that chondrites as extraterrestrial rocks were similar to terrestrial conglomerates; a famous conglomerate from Bruce Mines, Ontario fitted well (adjacent pebbles are as much as 500 million years different in age). Thinking of sand and pebble detritus revealed previously ignored complexities to be considered in the development of chondritic textures. Chondrules could be seen to have been modified during transport: w,a,i,f,s system to describe chondrule shape. Complexities revealed by considering the chondrule/matrix interface along with chondrule shape, possibly hardness variation. Cf. grains, pebbles, cobbles in a stream (or a tumble-polisher), with interstitial abrasive, pebbles of the same hardness or not [1,7].

Conclusions: Meteorites are fragmental rocks, most like terrestrial detrital sediments. Early grains preserved as relics in chondrites represent dust and gas in space. They are processed to become chondrules, enriching e.g. the planetary disk (spheroid, ellipsoid, discoid distribution) in a developing solar system. The resultant body of processed and unprocessed dust (fiefdoms) coagulates e.g. to form planets/asteroids/comets. Consider a block diagram of eroding dendritic stream systems, like a river valley starting at a glacial cirque, water and sediments ending in a delta (cf. Mars 2020). A single chondrule is like a pebble swept downstream, preserving evidence of its origins and journey, deposited to become part of a rock again.

References: [1] Herd R.K. (2019) *LPS L,* Abstract #3093; [2] Dixon L. 2009. A detailed investigation of the mineralogy and textures of the L4 ordinary chondrite Saratov: towards a new classification scheme for chondrules. B.Sc. thesis, Carleton University, Ottawa, Ontario, Canada; [3] Herd R. K. (2017) *80th Annual Meeting of the Meteoritical Society, LPI Contribution No. 1987,* Abstract #6362, p. 64; [4] Gooding J.L. & Keil, K. (1981) *Meteoritics & Planetary Science* 16: pp. 17-43 [5] Herd R. K. (2015) *LPS XLVI,* Abstract #2824; [6] Herd R. K. (2018) *LPS XLIX,* Abstract #2790; [7] This study.