Industrial Utilization of Concretions, Nodules, Segregations and the Shales Containing Them

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Commercial utilization of disseminated, mineral segregations depends upon a number of favorable special conditions operating in conjunction. The economic requirements are interrelated and may be complex. What the conditions and requirements are, can only be suggested in a general way and cannot be expected to apply strictly to any given specific case. Some of the factors involved in the exploitation of such mineral segregations are indicated in the following:

A. There must be at hand, mineral deposits that are already exploited or that have, as border line cases, a potential for commercial utilization by reason of favorable location, sufficient extent and suitable quality. The function of these is to serve as centers of concentration for the collection of similar but more disseminated ores or minerals, while continuing to operate themselves and augment their limited reserves by continual supplies from the disseminated segregations. The larger deposits serve as central markets for the scattered smaller ones. Oklahoma has such potential central markets in sizeable deposits of iron and manganese for the smaller, more widely disseminated iron and manganese nodules that exist in clays and shales and which represent, in the aggregate, large tonnages of ore in extensive geological formations. Similarly, large tonnages of barite have long been known to exist disseminated through extensive deposits of shale. Likewise, large amounts of disseminated but high grade phosphate exist and the presence of much greater tonnage is reasonably suspected. Analogous to the disseminated phosphate, widely scattered buffalo bones which are rich in phosphate were collected in wagon loads by the pioneers who hauled them to stations along the railroads where agents of fertilizer and chemical companies bought them and shipped them to St. Louis, Mo, where they were processed into the products sold by the firms in question. The same procedure worked for the disseminated barite of southwest Missouri. Examples could be multiplied if there were any point in doing so.

B. Another factor is the possibility of the beneficiation of the minerals in the deposit, i.e. of increasing their percentage content of "active principle". Often, procedures for doing this are relatively simple. They may consist of merely a physical operation such as screening or washing a clay to remove objectionable segregations thereby improving the clay and concentrating the values represented by nodules themselves. If chemical treatment is required, equally uncomplicated procedures are often available to a competent industrial chemist. Seldom is any mineral or ore so pure as to require no treatment whatever.

C. Another desirable practice is diversification. A collection center, possibly, should handle several raw materials, preferably those that can be used together, perhaps iron and manganese ores with charcoal for fuel reduction. Besides being a center for collecting the output of small ore producers, this depot could well serve as a distributing agent

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to manufacturers using the raw materials collected. There are several choices for this facility.

D. To start with, preference should be given to such processing of mineral raw materials as require a minimum of plant equipment and financing. Phosphate rock can be converted to superphosphate fertilizer with little more equipment than a grinder, mortar bed and hoe. It is a matter of record that prosperous industries have started on the kitchen stove. Financing should feature long term low interest loans. One prosperous industry that could be mentioned is profitably operating today but its founder is not benefitting because he neglected long-term financing. If warranted, expansion of an enterprise can take place later.

E. Perhaps the processing of mineral raw materials should aim, at first, at local production of such items as can compete with those that otherwise are imported into the trade area at relatively high shipping charges. Examples may be iron salts required for soil conditioning and water treatment, iron pigments, mineral colors, lithopone, titanium white, superphosphate, spiegeleisen, etc.

F. Some commercial values, segregations may have, do not require processing. If a nodule is so pure and has such outstanding characteristics that it rates as a specimen, its value is enhanced far above any it might have as a raw material for the processing industries. Barite and marcasite nodules of high chemical purity are outstanding examples of radiate structure. Pure phosphate nodules, when almost perfectly spherical, exhibit marked concentric structure. Well crystallized minerals of almost any kind generally have specimen values. When nodules rate as curios, values soar above even specimen rating. Barite nodules resembling roses, the so-called "rock roses" even though impure chemically, because of the resemblances are considered curios and are valued accordingly, far above mere specimen rating.

There are numerous individual specimens of "Rock Roses", consequently they are not unique curios. However, among these nodules classed as "Roses", one was found markedly resembling a curled-up sleeping dog with his nose tucked, characteristically, in his flank. This remarkable figure, realistically sculptured by nature herself is really unique and valuable accordingly. Such a "conversation piece" would bring whatever price a seller might see fit to ask and an interested buyer be willing to pay. Naturally formed objects like this are likely to be found among nodular deposits and are often sought by hobbyists in search of such items.

Next following is a sequence detailing as much information on segregations as is available in the literature cited in the bibliography at the end of this article. Each entry in this list of publications is referred to by a Roman numeral and pages in the given reference are cited by Aabic numerals. Underlined Arabic numerals refer to items in this article, primarily in the table of Locations. For example, *V, 1* p 207 refers to page 207 in the last entry, *V* in the Bibliography and concerns item, *1* in the table of "Locations". The information given is more complete than would be necessary if some of the publications were not "out of print". Not all items are of equal reliability as some served only as rough field descriptions of features in formations examined for other purposes. Qualitatively, the mineralogical composition of the segregations are often too vaguely identified for either scientific or commercial requirements. For instance, "iron concretions" should be identified as siderite, limonite, hematite, pyrite, marcasite etc. so that segregations at one location could be readily compared with those from another and composite mixed samples of each species from all locations could be chemically analyzed to give an idea of what quality of the raw material, on the average, is available for processing. The chemical analysis of the composite sample should be a complete one, both qualitative and quantitative, to reveal the presence of trace-and rare-elements, if any.

The tonnage of potentially valuable mineral segregations in a formation is frequently enormous; that available in accessable deposits in the formation, less so, but still considerable.

Quantity is equal to quality in importance when attempting to evaluate any given mineral (or other) raw material. Estimation of the amount of segregation in several deposits is difficult but necessary, especially when the concentrations are small. Since cursory examinations often neglect the quantity factor almost entirely, special attention to this is imperative when commercial exploitation of segregations is contemplated.

I, 4 p 35. Ferruginous concretions of sand and clay in Bokchito Formation, about 140 feet thick.

I, 17 p 36. The Bokchito Formation contains at least two horizons in which there is an abundance of highly fossiliferous, ferruginous clay-sand concretions. The Bokchito Formation disintegrates to form a reddish brown soil that is characterized by a large number of small ironstone fragments and concretions. In the section, 2 feet and 5 inches below the top (surface) a 37-foot, 4-inch shale bed contains iron concretions and shell beds in which the fossils are replaced by iron. Compare with Nos. *4*, *24*, and *25*.

II, 18 p 39. In the section described, 17 feet, 8 inches below the top, there is a soft, yellowish-white sand, 4 feet thick that contains clay-ironstone concretions and marcasite nodules in its lower portion. Two feet and 4 inches below the 4-foot sand is an 8-inch bluish-gray clay that contains clay-ironstone concretions and marcasite nodules. One foot, 4 inches below the 8-inch clay is a 1-foot, 8 inch clay that contains iron concretions. One foot, 3 inches below the last clay is an 8-foot 6-inch bluish gray shaly clay layer containing numerous clay-ironstone concretions and marcasite nodules. One foot, 2 inches below the last bed is a bluish gray shale that contains numerous small iron concretions in its upper part. There are 14 feet and 10 inches of the whole 54 feet, 1-inch section, that contain iron-bearing concretions and nodules. The section is exposed on the east bank of the Washita River, just below the St. Louis and San Francisco railroad bridge west of Woodville, and represents the Weno Clay member of the Bokchito Formation. *II, 19* p 39-*II, 21* p 40 inclusive describe the seperate iron bearing layers in the section of *II, 18.*

II, 22 p 41. A bed of bluish to brownish-yellow clay 57 feet thick contains numerous iron concretions in its lower part.

II, 23 pp 43, 44. The top of the section is a 38 foot soft yellowish-brown sandstone containing numerous veins of limonite. Below the sandstone is a 22 foot blue-yellow clay bed containing ironstone concretions. This Pawpaw member of the Bokchito Formation weathers to a very ferruginous soil, the surface of which is often covered with iron concretions and segregations. Frequently small hills are capped with a mass of limonite which has accumulated by the weathering of the Pawpaw. The Woodbine Sand resembles the Pawpaw and weathers like it. There are large quantities of ferruginous segregations in the Woodbine. There is an outlier North of Woodville.

III, 2 p 35. Spoil from the strip-pit mining ranges from yellow clay to carbonaceous shale with abundant ironstone nodules present in different portions of the pit.

III, 7 p 38. The strip-pit spoil contains considerable ironstone nodules on the overburden.

III, 16 p 41. The carbonaceous shale in the strip-pit spoil is characterized by an abundance of ironstone nodules.

III, 26 p 43. Clayey spoil from strip-pit mining contains ironstone and there is an abundance of pyritized fossils.

III, 31 p 43. Gray to buff calcareous shale and/or sandstone characterizes most of the surface spoil. Clayey material and ironstone nodules are present.

IV, 3 p 101. The shale is soft and contains some green pebbles.

IV, 6 p 114. The McAlester shale contains one bed of iron concretions and some micaceous lentils.

IV. 8 p 121. The Cherokee Shale contains some iron concretions.

IV. 9 pp 80, 118. Fayetteville Shale contains some ocherous concretions.

IV. 10 pp 80, 118. Fayetteville Shale contains some ocherous concretions.

IV. 11 p 120. Cherokee Formation contains numerous streaks of oxidized iron.

IV. 13 p 134. Calcite concretions occur scattered in the lower part of the shale zone.

IV. 14 p 141. At Keota, the McAlester Shale contains some iron concretions. The Formation is badly iron stained.

IV. 15 p 154. In the hill, the section shows 13 feet of gray-green shale with limonite zones.

IV. 24 p 168. 140 feet of mostly clay containing ironstone concretions.

IV. 27 p 177. The Senora Shale is discolored with iron impurities.

IV. 28 p 185. The Hennessey Shale contains green inclusions.

IV. 30 p 190. The Stuart Shale at Kusa, contains iron concretions.

IV. 34 p 215. A maroon Pontotoc Shale contains numerous Barite concretions.

V. 1 p 207. Winslow Shales contain ocherous concretions.

V. 5 pp 123, 124. Clay shale with concretionary structure. Concretions show much ferrous carbonate and little lime. The Concretions are plentiful and hard to separate.

V. 12 p 248. Six inches to one foot of iron ore, principally limonite.

V. 25 p 185. Surface clay with small iron concretions. Brown color is due to manganese.

V. 29 p 244. Shale often concretionary and there are several kidney-shaped ironstone concretions which seem to be all limonite. The larger concretions are thrown out as the cars are loaded.

V. 32 p 199. Lower part of the black, bitumenous, fissil Caney Shale contains spherical calcareous segregations.

V. 33 p 199. Just above *32*. The clay shales include small ironstone concretions. Caney Shale.

LOCATIONS WHERE CONCRETIONS, NODULES AND OTHER SEGREGATIONS MAY BE FOUND

County	Location	Formation	Thickness	Remarks	
Adair					
1	Skin Bayou	Winslow		Disseminated Ocherous Fe.	*V.*
Atoka					
2	Secs. 3, 10, 11-T2S-R10E.	McAlester (?)	30 feet	Many ironstone nodules	*III.*
Blaine					
3	Greenfield, 1⅓ mi. NE of W. of RR. East Slope of Hill.	Flower Pot	80 feet	Contains GREEN pebbles	*IV.*
Bryan					
4	Bokchito, near. On Bokchito Creek.	Bokchito	140 feet	Ferruginous concretions	*I.*
Coal					
5	Coalgate. SE¼ Sec. 14-T1N-R10E.	McAlester	20′×Miles	Many $FeCO_3$ concretions	*V.*
6	Coalgate, 2½ mi. from Coalgate-Cairo highway	McAlester	40 feet	One bed Iron concretions Micaceous lentils.	*IV.*
Craig					
7	Sec. 27-T26N-R19E.	Boggy (?)	15 feet	Considerable Ironstone nodules.	*III.*
8	Vinita, 6 mi. N of. Fresh cut, Hwy 73 NW sec. 23-T26N-R20E.	Cherokee	15′+	Some iron concretions.	*IV.*
9	NE Sec. 13-T25N-R20E.	Fayetteville	60′-100′	Some ocherous concretions.	*IV.*
10	SW. Sec. 8-T25N-R21E.	Fayetteville	60′-100′	Some ocherous concretions.	*IV.*
11	Bluejacket, 1 mi. E. of. SE Sec. 19-T27N-R21E.	Cherokee	40 feet	Many yellow Iron streaks.	*IV.*
Creek					
12	Sapulpa. Sapulpa Group. Shales	Skiatook	6″-1′	1 layer of LIMONITE.	*V.*
Garvin					
13	Pauls Valley, S of. 0.4 mi E cemetery, in an erosional draw.	Enid		Calcite concretions in the lower part.	*IV.*

LOCATIONS WHERE CONCRETIONS, NODULES AND OTHER SEGREGATIONS MAY BE FOUND

County	Location	Formation	Thickness	Remarks	
Haskell					
14	Keota. NW Sec. 18-T9N-R23E.	McAlester	35′+	Some iron concretions.	*IV.*
Kiowa					
15	Hobart, 1 mi. N of. NWSW35-T7N-R18W.	Clear Fork-Wichita	30′+	LIMONITE zones in Shale.	*IV.*
LeFlore					
16	Sec. 15-T9N-R24E	McAlester (?)	15′-25′	Many ironstone nodules.	*III.*
Love					
17	Section on E bank, Red R. ¼ mi. N of Tucks Ferry, NW cor 13-T8S-R2E.	Bokchito	37′4″	Iron concretions and replacements.	*I.*
Marshall					
18	Woodville, W of Sec. on E bank of Washita R. Bokchito Formation	Weno Clay Member	4 feet	Clay-ironstone concretions and MARCASITE nodules.	*II.*
19	Woodville, W of Sec. on E bank of Washita R. Bokchito Formation	Weno Clay Member	8 inches	Ironstone concretions and many MARCASITE nodules.	*II.*
20	Woodville, W of Sec. on E bank of Washita River. Bokchito Formation.	Weno Clay	8′6″	Many iron concretions and MARCASITE nodules.	*II.*
21	Woodville, W of Sec. on E bank of Washita R. Bokchito Formation.	Weno Clay Member	11′10″	Many iron concretions in upper part.	*II.*
22	Woodville, due E of. W bank of Washita River, Bokchito Formation	Weno Clay Member	57 feet	Many iron concretions in lower part.	*II.*

LOCATIONS WHERE CONCRETIONS, NODULES AND OTHER SEGREGATIONS MAY BE FOUND

County	Location	Formation	Thickness	Remarks	
Marshall					
23	Woodville, due E of. W bluff of Washita River. Bokchito Formation	Pawpaw Member	60 feet	Iron concretions. Masses of LIMONITE weather out.	*II.*
McCurtain					
24	Garvin, near. NESE 13-T7S R22E Bokchito Formation	Washita Group	140 feet	Ironstone concretions in clay.	*IV.*
25	Garvin. Sec. 13-T7S-R22E		10′×40 acres	Small iron concretions in clay. Brown color due to manganese.	*V.*
McIntosh					
26	Secs. 29, 31, 32-T12N-R18E	Boggy (?)	15′-20′	Ironstone, many pyritized fossils.	*III.*
Muskogee					
27	Haskell, near Sec. 5-T16N-R15E	Senora Shale	12′ shale 8′ soil	Iron discolored shale.	*IV.*
Oklahoma					
28	Bethany, N of NE. NE 32-T13N-R4W	Hennessey Shale	30′+	GREEN inclusions.	*IV.*
Okmulgee					
29	Gaither, 4 mi. E. of Okmulgee	Shale	15′×1.75 A.	Kidney shaped LIMONITE concretions of which the larger are discarded when wagons are loaded.	*V.*
30	Kusa, at Sec. 3-T11N-R13E.	Stuart Shale	80′+	Iron concretions.	*IV.*
31	Sec. 8-T13N-R14E.	Morris		Ironstone nodules.	*III.*
Pontotoc					
32	Ada, near Lower part of Caney	Caney Shale		Spherical calcareous segregations.	*V.*
33	Ada, near Lower part of black Caney Shale	Caney Shale		Small ironstone concretions.	*V.*
Pottawatomie					
34	Tecumseh, SW depot along RR tracks. Sec. 13-T9N-R3E.	Pontotoc Shale	15′+	Many BARITE concretions in maroon colored shale.	*IV.*

ANNOTATED REFERENCES

I. Bullard, Fred M. Geology of Love County, Okla. Geol. Surv. Bull. 33 (1925) *4*. p 35: *17* p 36.

II. Bullard, Fred M. Geology of Marshall County, Okla. Geol. Surv. Bull. 39 (1926) *18*. p 39: *19* p 39: *20* p 40: *21* p 40: *22* p 41: *23* pp 43,44.

III. Doerr, Arthur H. Coal Mining and Landscape Modification. Okla. Geol. Surv. Circ. 54 (1961). *2* p 35: *7* p 38: *16* p 41; *26* p 43: *31* p 43.

IV. Sheerar, Leonard Francis. The Clays and Shales of Oklahoma. Okla. A. and M. College, Div. Eng. Publ. Vol. 3, No. 5. (1932) *3* p 101: *6* p 114: *8* p 121: *9* pp 80,118: *10* pp 80,118: *11* p 120: *13* p 134: *14* p 141: *15* p 154: *24* p 168: *27* p 177: *28* p 185: *30* p 190: *34* p 215.

V. Snyder, L. C. Clays and Clay Industries of Oklahoma. Okla. Geol. Surv. Bull. 7 (1911) *1* p 207: *5* pp 123,124: *12* p 248: *25* p 185: *29* p 244: *32* p 199: *33* p 199.