Journal of the Arkansas Academy of Science

Volume 36 Article 45

1982

Sr/Mg Ratios of Pennsylvanian Limestone Units in Northwest Arkansas

George H. Wagner
University of Arkansas, Fayetteville

Kenneth F. Steele
University of Arkansas, Fayetteville

Doy L. Zachry
University of Arkansas, Fayetteville

Recommended Citation

Wagner, George H.; Steele, Kenneth F.; and Zachry, Doy L. (1982) "Sr/Mg Ratios of Pennsylvanian Limestone Units in Northwest Arkansas," *Journal of the Arkansas Academy of Science*: Vol. 36, Article 45.
Available at: https://scholarworks.uark.edu/jaas/vol36/iss1/45

Adherence to specific guidelines could significantly reduce or eliminate much of the environmental impact from these developments. Land extensive projects should be developed in phases. A 70 to 80 percent buildout should be required before expansion to new areas is allowed. This would eliminate much of the unnecessary road network and prevent the continued expansion of "premature" subdivisons. Roads should preserve existing topography to reduce disruption of the natural drainage network and the need for cut and fill (Allen et al., 1976).

Developers should be required to preserve water resources by limiting withdrawal to an environmentally "safe" yield and limit the use of septic tanks on individual lots. These practices would reduce the rate of water table decline, salt water intrusion, and pollution of shallow aquifers (Allen et al., 1976).

Large areas of open space should be required, and development of wetlands, steep slopes, and fragile areas avoided. Open space could be used as parks, wilderness areas, and greenbelts along streams (Allen et al., 1976).

Many of these suggestions obviously can not be met by developers because of the restrictive nature of the fragile environments they have chosen to develop. The three most intensely developed areas, the desert southwest, the mountains of Colorado, and the wetlands of Florida, have major environmental limitations which are serious enough to make such enormous developmental activity highly questionable, especially since buildout rates are low and these developments are not responding to a real need for housing.

Developers should be required to establish sound, legitimate, and justifiable land development operations that blend with the needs of the region and conform to the environmental constraints of a particular area. Those unwilling to work within existing environmental limitations should not be allowed to proceed with development.

Figure. Recreational subdivisions of 1,000 acres or more in the United States.

LITERATURE CITED

ALLEN, L., B. KUDER, and S. L. OAKES. 1976. Promised lands. Vol. I: subdivisions in deserts and mountains. Inform, Inc. New York, 560p.

AMERICAN SOCIETY OF PLANNING OFFICIALS. 1976. Subdividing rural America: impacts of recreational lot and second home developments. U. S. Government Printing Office, Washington, D. C., 134p.

CARTER, L. J. 1974. The Florida experience. Johns Hopkins Univ. Press, Baltimore, Maryland, 355p.

PAULSON, M. C. 1972. The great land hustle. Regnery Company Press, Chicago, Ill., 240p.

RAGATZ, R. L. 1970. "Vacation homes in the northern United States: seasonality in population distribution." Ann. Assoc. Amer. Geog. 60:386-455.

STROUD, H. B. 1978. "The land development corporation: a system of selling rural real estate." Real Estate and Urban Econ. Assoc. 6:271-286.

U. S. DEPT. OF HOUSING AND URBAN DEVELOPMENT. 1981. Office of Interstate Land Sales Registration Catalogue Report. Washington, D. C., 2620p.

HUBERT B. STROUD, Department of Sociology, Social Work, and Geography, Arkansas State University, State University, Arkansas 72467.

SR/MG RATIOS OF PENNSYLVANIAN LIMESTONE UNITS IN NORTHWEST ARKANSAS

In a previous publication (Wagner et al., 1979), a linear relationship was noted between the Sr and Mg contents of 5 Carboniferous limestone units in northwest Arkansas. Such correlations held only within a given limestone unit, not between different units. It now appears that this relaship is a paleontological one with the Sr/Mg ratio of the limestone being determined by its fossil content. The latter can be determined by petrographic examination. Using Sr and Mg contents for recent specimens of the fossils from standard texts, a weighted average composition can be calculated for the original prediagenetic limestone unit. These calculated Sr/Mg ratios based on fossil content are within a few per cent of the actual ratio for outcrops of the Brentwood and Kessler limestone units.

Davis (1961) has done an extensive petrographic study of the Brentwood Limestone. Using a water lubricated saw, samples 1 cm thick were obtained adjacent to and parallel to his thin section samples. These were dissolved in hydrochloric acid and analyzed by atomic absorption spectrophotometry as described previously (Wagner et al., 1979). A suite of samples were selected which came from the perimeter of a 10 x 10 mi. area in southwest Washington County of Arkansas. The sample numbering and identification (MA = Morrow Anticline, HS = Hale Mt. Syncline and CA = Cove Creek Anticline) are the same as Davis' (1961) and this reference may be consulted for the exact location of samples and petrographic details.

The table summarizes 1) the position of each sample in its stratigraphic column and compares it petrographically and chemically to a column weighted average, 2) the calculated and determined chemical compositions and 3) the calculated amount of diagenesis. The first column in the table gives the total thickness of the section and the heights above the base where the samples were taken. The calculated compositions are weighted averages using the Sr and Mg contents listed in the last two lines of the table for the various fossils. The per cent diagenesis of an element is (calculated wt. % - actual wt. %) divided by the calculated wt. % times 100. Thus, the per cent diagenesis is based on the loss of Sr and Mg.

The calculated Sr/Mg ratios average 20% less than the actual ratios in 8 samples and 6% greater in 2 samples. This is indicative of slightly greater diagenesis of Mg than Sr. Average chemical compositions which were calculated for the entire limestone columns show no significant differences among themselves or when compared to single samples within the column. This is a result of the small differences in the chemical compositions assigned to the recent forms of the principal fossils, crinozoa and bryozoa. The actual analyses show a uniform composition also which could result from equilibration of the chemical composition of the sediment column during its lithification. There apparently is no major change in chemical composition between megafossils and the spar as the spar content varies from 8 to 48 wt. % among these samples and this variation has no apparent effect on the Sr/Mg ratios. Brand and Veizer (1980) have also noted only small changes in Sr concentrations between different fossils and spar in the Mississippian Burlington Limestone of Iowa and Missouri.

It will be noted in the table that the actual Sr and Mg contents of 4 of the 5 sample pairs increased slightly in going up the column. This is indicative of more diagenesis for the first deposited materials, which seems reasonable. Although the geologic ages of the samples in a column are about the same, the samples lower in the column had more "formative" years, when diagenesis was most active. Another explanation is that the temperature in the sea during the period of deposition may have increased in proceeding up the stratigraphic column. any of these fossil organisms form skeletons that incorporate more Sr and Mg as the water temperature increases.

The above explanations for the increase of Sr and Mg with heights in the column must be reconciled with the following: 1) the concentration of the partially soluble fraction increases with height and 2) 60% of the Sr and Mg comes from the partially soluble fraction (Wagner et al., 1979). Authigenic formation of the partially soluble fraction or its presence in the living fossil organisms, rather than a terrigenous sediment source, would reconcile these items with the main concept of this report.

Calculations have also been made on Kessler Limestone similar to those done above on Brentwood Limestone. The Sr/Mg ratios calculated for 3 kessler outcrops from its fossil mix differ by only 0, 5 and 10% respectively from that determined chemically. Samples higher in the columns and a fourth outcrop differ up to 40% betwen actual and calculated.

Lowenstam (1961) has compared the compositions of recent and fossil brachiopods and interpreted the differences in terms of diagenesis, water temperature and salinity. Three of the fossil specimens were from a Mississippian shale formation, but with their calcite structures intact. These Mississippian fossils had lost more Mg than Sr. We find just the opposite for the brachiopodi-bearing (4-30% of the fossils) Kessler Limestone. However, in the Brentwood Limestone diagenesis of Sr and Mr is about the same as shown by the table.

Table. Brentwood Limestone, Fossil Compositions and Calculated and Measured Chemical Composition.

Sample	Height Ft.	No. Samples Counted	Crinoidea %	Bryozoa %	Brachiopoda %	Foraminifera (benthonic) %	Calculated wt. %		Actual wt. %		Atom Ratio Sr/Mg		% Diagenesis	
							Sr	Mg	Sr	Mg	Calc.	Found	Sr	Mg
MA-1-4	13	1	15	63	-	22	0.217	2.96	0.030	0.320	0.020	0.026	86	89
MA-1-5	18	1	83	17	-	--	0.205	3.46	0.040	0.536	0.016	0.023	78	85
MA-1-total	28	7	63	33	1.7	2.7	0.209	3.27	--	--	0.018	--	--	--
MA-2-3	5	1	25	75	-	--	0.222	3.02	0.025	0.301	0.020	0.023	89	90
MA-2-5	8	1	69	31	-	--	0.209	3.36	0.032	0.543	0.017	0.016	85	84
MA-2-total	10	5	41	59	-	--	0.218	3.14	--	--	0.019	--	--	--
CA-2-1	12	1	72.4	27.6	-	--	0.208	3.39	0.039	0.387	0.017	0.028	81	89
CA-2-4	30	1	15.6	84.4	-	--	0.225	2.93	0.051	0.549	0.021	0.026	77	81
CA-2-total	32	5	56	42	2.0	--	0.212	3.22	--	--	0.018	--	--	--
CA-4-1	6	1	40	60	-	--	0.218	3.14	0.032	0.335	0.019	0.026	85	89
CA-4-4	17	1	56	44	-	--	0.213	3.26	0.032	0.297	0.018	0.030	85	91
CA-4-total	21	5	52	48	-	--	0.214	3.23	--	--	0.018	--	--	--
HS-4-3	5	1	20	80	-	--	0.224	2.98	0.036	0.416	0.021	0.024	84	86
HS-4-4	6	1	51	45	4.0	--	0.212	3.15	0.041	0.621	0.019	0.018	81	80
HS-4-total	7	4	53	46	1.0	--	0.213	3.22	--	--	0.018	--	--	--
Mg (wt.%)	--	-	3.6^{a}	2.83^{e}	0.98^{d}	2.87^{c}								
Sr (wt.%)	--	-	0.2^{b}	0.23^{c}	0.17^{d}	0.19^{e}								

a. data from Weber (1969).
b. data from Fig. 42, Milliman (1974). The average of other echinodermata because there are no data for crinoidea.
c. data from Table 28, Milliman (1974). The average for *Bulgula, Eucratia* and *Membranipora,* all magnesium calcites.
d. data from Table 1, Lowenstam (1961). The average for first 9 species grown in normal salinity and 23-25.8 °C.
e. data from Table 21, Milliman (1974). The average for benthonic forms.

LITERATURE CITED

BRAND, U., and J. VEIZER. 1980. Chemical diagenesis of a multicomponent carbonate system - 1: trace elements. Jour. Sed. Petrology 50(4):1219-1236.

DAVIS, C. L. 1961. Petrography of the Brentwood limestone in Washington County, Arkansas. M. S. Thesis. University of Arkansas, Fayetteville. 281p.

LOWENSTAM, H. A. 1961. Mineralogy, 0^{18}/0^{16} ratios, and strontium and magnesium contents of recent and fossil brachiopods and their bearing on the history of the oceans. Jour. Geology 69(3):241-260.

MILLIMAN, J. D. 1974. Marine Carbonates. Springer-Verlag, New York, 375p.

WAGNER, G. H., K. F. STEELE, R. H. KONIG, and D. L. ZACHRY. 1979. Geochemistry of carboniferous limestone units in northwest Arkansas, Chem. Geol., 24:293-313.

WEBER, J. N. 1969. Incorporation of magnesium into the skeletal calcites of echinoderms. Am. J. Sci. 267(5):537-66.

WILLIAMS, J. G. 1972. Sedimentary petrology of the Kessler limestone, Washington and Crawford counties, Arkansas. Unpubl. M. S. Thesis, University of Arkansas, Fayetteville. 112p.

GEORGE H. WAGNER, KENNETH F. STEELE, and DOY L. ZACHRY, Geology Department, University of Arkansas, Fayetteville, Arkansas 72701.