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Chemostratigraphy of Paleozoic Carbonate in Natar, South Lampung, Indonesia

Darwin Jansen Parningotan Sihombing[1,a], Danni Gathot Harbowo[2,4], Bambang Priadi[2], Luki Ardhianto[3]

[1] *Department of Geological Engineering, Institut Teknologi Sumatera, Wayhui, Lampung, Indonesia.*
[2] *Department of Geological Engineering, Institut Teknologi Bandung, Bandung, Indonesia.*
[3] *PT Aneka Sumberbumi Jaya, Lampung, Indonesia.*
[4] *Sedimentology, Stratigraphy, and Geodynamic Research Group, Institut Teknologi Sumatera, Wayhui, Lampung, Indonesia*
[a] *Corresponding author:*

Abstract

Located in Natar, South Lampung, there is paleozoic carbonate included in the Gunungkasih Formation members. It is supposed to explain the geological history's uniqueness to the paleoenvironment during the Paleozoic age in western Indonesia. We concern with identifying the lithofacies by chemostratigraphy. We used several representative core data in this area. We determined the correlation of chemostratigraphy by CaO, MgO, SiO_2, Fe_2O_3, and Mn concentration. It is to interpret the paleozoic paleoenvironment. The chemical range in stratigraphy is CaO 47.4-55.3 %; MgO 0.51-8.12 %; SiO_2 0.21-1.20 %; up to 0.12% of Fe_2O_3; and up to 162 ppm of Mn. We concluded that the paleoenvironment of this unit was dominated by massive paleozoic coral reef facies that formed in the margin of warm-shallow marine.

Keywords: Paleozoic carbonate, chemostratigraphy, paleoenvironment, South Lampung.

Introduction

The research was conducted in Natar, South Lampung, with the object of research being paleozoic carbonate rocks in the form of marble which are members of the Gunungkasih Formation. The local geological setting consists of the Paleozoic Gunungkasih Fm., surrounded by quarternary pyroclastic rocks (Figure 1). One of them is marble rock, also known as paleozoic carbonate rock. It is presumed that the marble rocks in the study area can explain the unique geology related to the paleoenvironment during the Paleozoic age in western Indonesia (Mangga et al., 1993; Natalia et al., 2020; Zulkarnain, 2011)

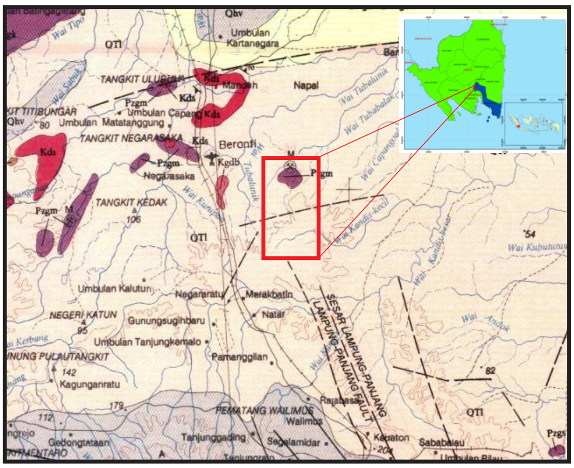

Figure 1. Geological Map of the Tanjung Karang Sheet (Mangga, et al., 1993), red box shown the area of interest.

Chemostratigraphy is an application for stratigraphy with geochemical data on core rocks. Rock identification can be used with geochemical data and core data in the form of chemostratigraphy. Comparison of the abundance of calcium oxide is one of the results that need to be obtained to determine the characteristics of marble rocks with impurity rocks.

Data and Methods

The study used primary data in the form of core descriptions and secondary data in geochemical data. The method used is chemostratigraphy from the correlation of core and geochemical data (refer to Melezhik et al., 2015; Rowe et al., 2012).

Geochemical data is secondary data from a marble (limestone) mining company in the Natar area. Geochemical data are contained in two data 1st wells DH1 (Table 1) and 2nd wells DH4 (Table 2). This data is analyzed from X-ray fluorescence (XRF) analysis of marble cores.

Geochemical data analysis uses geochemical test data on core samples by testing marble rocks with excellent physical characteristics without any iron oxide impurities or the slightest intrusion of andesite. So the samples taken and tested have different thicknesses. The geochemical data obtained in this research are geochemical data that are measured only for CaO, MgO, SiO_2, Fe_2O_3, and Mn concentrations. At the same time, other elements are not reconsidered because the percentages are minimal.

Table 1. Geochemical data of marble rock 1st well (DH1).

WELL GEOCHEMICAL DATA DH1							
WELL	Depth From (m)	Depth To (m)	CaO (wt %)	MgO (wt %)	SiO2 (wt %)	Fe2O3 (wt %)	Mn (ppm)
SDH01_01	5.65	6.20	53.2	2.08	0.21	0.02	23
SDH01_02	6.20	6.70	47.6	6.22	0.54	0.05	162
SDH01_03	6.70	7.30	55.3	0.65	0.22	0.00	17
SDH01_04	7.30	8.20	55.2	0.71	0.25	0.00	7
SDH01_05	8.20	11.20	55.3	0.52	0.24	0.00	10
SDH01_06	11.20	12.90	54.0	1.33	0.26	0.01	10
SDH01_07	12.90	14.20	54.9	0.58	0.27	0.00	7
SDH01_08	14.20	15.60	54.8	0.84	0.35	0.03	19
SDH01_09	16.10	18.40	54.0	0.69	0.67	0.05	20
SDH01_10	19.10	20.30	53.9	0.51	0.55	0.05	32
SDH01_11	23.00	24.95	52.4	2.26	0.36	0.03	40
SDH01_12	26.30	27.70	51.6	2.91	0.58	0.10	27
SDH01_13	27.70	30.70	50.2	4.24	0.52	0.12	35
SDH01_14	30.70	32.30	50.8	3.78	0.38	0.07	45
SDH01_15	32.90	35.00	52.1	2.88	0.36	0.05	37
SDH01_16	36.00	38.00	51.5	3.15	0.34	0.04	22
SDH01_17	43.60	45.90	47.4	8.12	0.29	0.02	22
SDH01_18	45.90	48.50	51.3	3.30	0.51	0.06	18
SDH01_19	48.50	50.40	51.0	3.98	0.35	0.02	13
SDH01_20	53.20	55.50	49.8	2.41	1.20	0.06	62
SDH01_21	55.50	58.55	51.6	1.92	0.69	0.11	41

Chemostratigraphy was carried out by correlation and analyzing core descriptions with geochemical concentrations of marble cores from two different wells. The results of chemostratigraphy analysis are described by the characteristics of marble rocks with impurity rocks and the abundance of calcium oxide with other geochemical concentrations (Melezhik et al., 2014).

Table 2. Geochemical data of marble rock 2nd well (DH4).

WELL GEOCHEMICAL DATA DH4							
WELL	Depth From (m)	Depth To (m)	CaO (wt %)	MgO (wt %)	SiO2 (wt %)	Fe2O3 (wt %)	Mn (ppm)
SDH04_01	0.30	1.50	51.9	2.64	0.47	0.04	39
SDH04_02	3.00	5.00	54.3	0.57	0.37	0.01	14
SDH04_03	5.00	7.00	54.7	0.56	0.6	0.01	19
SDH04_04	7.00	9.00	54.4	0.82	0.36	0.01	11
SDH04_05	9.80	11.10	54.5	0.68	0.26	0.01	17
SDH04_06	11.40	13.20	54.1	1.08	0.33	0.01	13
SDH04_07	13.20	15.10	55.0	0.77	0.24	0.01	17
SDH04_08	16.40	18.40	54.4	0.68	0.39	0.02	26
SDH04_09	18.40	19.90	54.7	0.98	0.28	0.00	9
SDH04_10	20.60	22.80	54.8	0.78	0.25	0.01	10
SDH04_11	22.90	25.10	54.1	1.13	0.30	0.01	10
SDH04_12	25.10	27.40	52.3	2.68	0.24	0.01	10
SDH04_13	27.40	29.90	54.8	0.97	0.31	0.00	14
SDH04_14	30.20	32.60	55.0	0.73	0.29	0.00	6
SDH04_15	32.60	34.90	52.2	1.80	0.52	0.02	22
SDH04_16	34.90	37.20	52.4	0.90	0.82	0.05	37
SDH04_17	37.30	39.20	54.1	0.51	0.54	0.08	41
SDH04_18	43.10	46.00	54.7	0.79	0.29	0.01	11
SDH04_19	46.00	47.50	54.9	0.60	0.38	0.01	10
SDH04_20	52.20	54.60	49.5	4.36	0.54	0.09	39
SDH04_21	54.60	56.00	48.4	4.57	0.73	0.07	53
SDH04_22	56.20	57.00	49.0	5.51	0.42	0.22	38
SDH04_23	57.50	59.30	51.5	2.71	0.56	0.19	48
SDH04_24	60.00	63.50	50.8	3.57	0.64	0.10	36
SDH04_25	63.50	65.00	47.1	8.04	0.58	0.04	21
SDH04_26	65.00	67.50	49.3	5.13	0.43	0.03	18

Result and Discussion

The two data cores DH1 and DH4, the distance between the two wells is ± 116 meters. The coordinates of the well DH1 are at point 5° 14' 1.0" S, 105° 12' 47.6" E elevation ± 75 masl, and depth 59 meters. Coordinates of the well DH4 are at point 5° 14' 44.2" S, 105° 12' 50.5" E elevation ± 75 masl, and depth 69 meters (Figure 2).

The results of the description and analysis of cores in both wells show the characteristics of three rocks, namely marble, intrusion of andesite, and tuff. The characteristics of marble rocks are light gray to bluish-white color, non-foliated structure, crystalline, granoblastic texture, reacting with HCl in the presence of calcite minerals and some impurities such as iron oxide. Some parts are brittle and break easily. The characteristics of andesite intrusion are dark gray to greenish aphanitic, and there are calcite veins due to breaking through marble rocks. The characteristics of tuff are brown, and the grain size is ash-lapilli (1/16 – 64 mm), altered condition with the presence of pyrite mineral, open packed with marble rock fragments are calcareous.

The marble rock formed by contact metamorphism is shown by granoblastic and crystalloblastic texture (refer to Thomann and Hoffer, 1991). We suggest the protolith of the marble rock is originated from limestone indicated by the presence of a texture (relict) in the form of algae remains; the paleo-environment of this unit is controlled by massive paleozoic coral reef facies formed on the edge of warm shallow seas. (Winter. J. D., 2001; Titisari, A. D. & Kurniawati, S., 2018).

Geochemical core data in the DH1 well show geochemical concentrations with 21 data and different depths. The measured data starts from a depth of 5.65 meters to 58.55 meters. The lowest abundance of CaO is at a depth of 43.60-45.90 meters with a concentration of 47.4%, MgO concentration (8.12%), SiO2 concentration (0.29%), Fe2O3 concentration (0.02%) and Mn (22 ppm) and the largest at a depth of 8.20 – 11.20 meters with a concentration of 55.3%, MgO concentration (0.52%), SiO2 concentration (0.24%), Fe2O3 concentration (0.0%) and Mn (10 ppm).

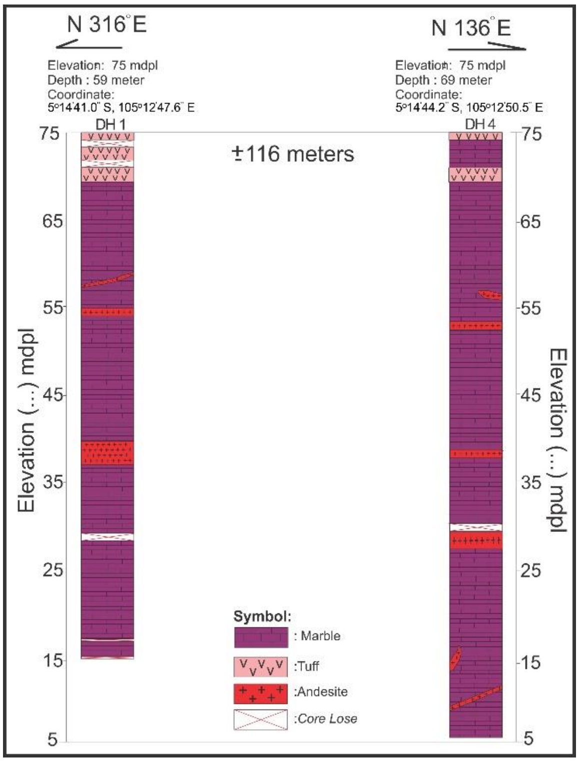

Figure 2. Illustration of a well from the data core.

Core geochemical data in the DH4 well show geochemical concentrations with 26 data and different depths. The measured data starts from a depth of 0.03 meters to 67.50 meters. The lowest abundance of CaO is at a depth of 63.5-65 meters with a concentration of 47.1%, MgO concentration (8.04%), SiO2 concentration (0.58%), Fe2O3 concentration (0.04%) and Mn (21 ppm) and the largest at a depth of 13.20 – 15.1 meters with a concentration of 55.0%, MgO concentration (0.77%), SiO2 concentration (0.24%), Fe2O3 concentration (0.01c%) and Mn (17 ppm). Based on the available geochemical data, diagrams can be made to determine the relationship between the abundance of calcium oxide (CaO) and impurity minerals (MgO, SiO2, Fe2O3, and Mn) originating from intrusion of andesite rocks. So it can be proven that these impurity minerals cause the decrease in the abundance of calcium oxide in marble.

In the analysis of the relationship of geochemical data in the DH1 and DH4 wells, it was shown that the abundance of calcium oxide (CaO) was inversely proportional to the abundance of MgO, SiO_2, Fe_2O_3, and Mn. Its means that when the abundance of CaO is higher, the abundance of MgO, SiO_2, Fe_2O_3, and Mn is lower, and vice versa when its abundance higher, the abundance of CaO is lower; this is evidenced in the geochemical data relationship diagram (see Figure 3).

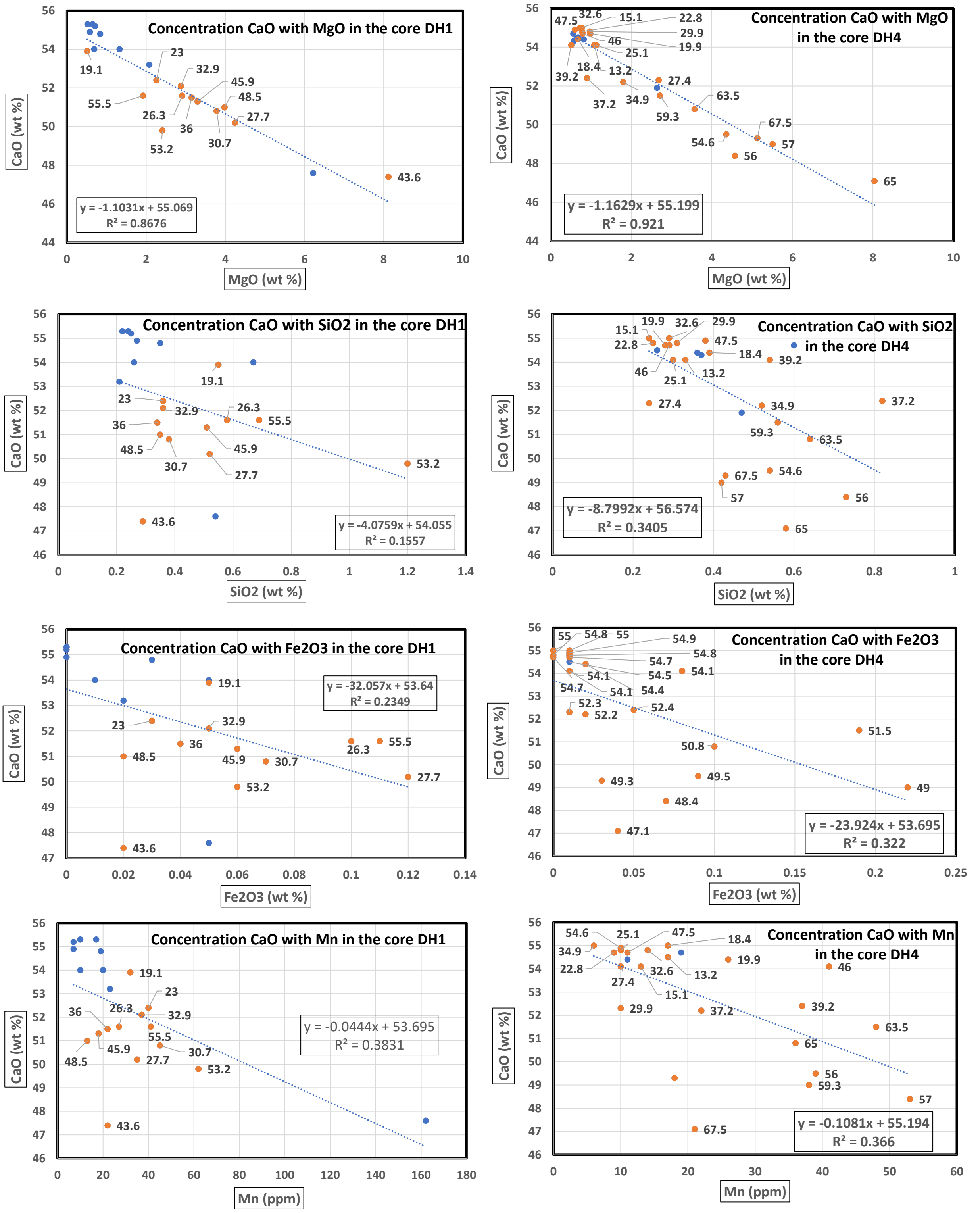

Figure 3. Corelation of CaO concentration with MgO, SiO_2, Fe_2O_3, and Mn of Well DH1 and DH4.

In the diagram, there is a dot symbol with two colors, and the blue dot describes the abundance of CaO before intense with andesite intrusion based on the core description. The blue orange dot describes the abundance of CaO after intense with intrusion of andesite. This figure describes the depth of the well.

Conclusions

As the results, we determined the correlation of chemostratigraphy by CaO, MgO, SiO_2, Fe_2O_3, and Mn concentration to interpreted the paleozoic paleoenvironment. The chemical range in stratigraphy is with 47.4-55.3 % of CaO; 0.51-8.12 % of MgO; 0,21-1.20 % of SiO2; up to 0.12% of Fe2O3; and up to 162 ppm of Mn. We concluded that the paleoenvironment of this unit was dominated by massive paleozoic coral reef facies that formed in the margin of warm-shallow marine.

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