



Analysis of Hot Spring Water Quality for Public Bathing at Danum Layong, Long Kali Village, Long Kali Sub-District, Paser Regency, East Kalimantan Province, Indonesia

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Abstract. Long Kali village has geothermal manifestation in the form of hot water known locally as "Danum Layong", which means "hot water" in the language of the local community. Since the site's inauguration in 2009, there has been a significant decline in visitor numbers, mainly due to inadequate construction and ongoing maintenance issues that have left the site in a state of disrepair. This research aims to carry out an analysis of the quality of hot water, with special emphasis on the characteristics of the surrounding lithology and the specific environmental conditions that exist at that location. Laboratory tests have results showing that, even though the hot water shows a high temperature, and the level of hardness is also high due to the limestone lithology that composes the research location, the high temperature maintains a neutral pH. The low iron content is due to the lithology of the constituent being clastic sedimentary rock. The results of this analysis classify water quality based on lithology as good. Meanwhile, based on the conditions of the research location, it is considered unfit but can be changed if improvements are made. Based on the two analyzes it can be concluded that this hot water is said to be feasible if repairs and renovations are carried out on the facilities and infrastructure at the location

Keywords: Danum Layong, Hot Spring, Hot Springs Quality.

1 Introduction

Long Kali is a village located within Paser Regency in East Kalimantan Province, notable for its geothermal manifestation, particularly the hot spring known as "Danum Layong," which translates to "hot spring" in the local community language. According to Adha et al., this hot spring is believed to be a manifestation of non-volcanic geothermal activity, primarily consisting of extensive limestone formations [1]. However, the site has been facing significant challenges related to maintenance and infrastructure, particularly concerning deteriorating road access and the condition of

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the hot spring pools. As a result, there have been no visitors for five years since its opening in 2009. To initiate improvements at this location, a quality analysis was conducted that focused on the lithological composition and environmental conditions of the research area. This assessment aimed to determine whether the hot water available in this region is suitable for use by the local community.

The research site is situated within the Bebulu formation, characterized by lithological features that include limestone interspersed with mudstone, siltstone, and minor marl deposits. Fossils discovered in the area, such as *Lepydocy Clina ephippioides* JONES & CAPMAN, *Lepydocy Clina* sp., *Operculina* sp., *Operculinella*, *Miogypsinoides*, and *Cycloclypeus*, suggest an Early Miocene age and indicate deposition in a shallow marine environment, with a thickness reaching up to 1900 meters. This formation is known to overlap with the Pamaluan formation [2].

2 Materials and Methods

In this research, a method was carried out in the form of hot water quality analysis based on the lithology that makes up the research area and the conditions at the research location. The data used in this research is primary data in the form of lithological data and data from observations of the research location, while the secondary data used in this research is data from laboratory tests from hot water samples at the research location which are then linked to the results of these tests with lithology and conditions of the research location.

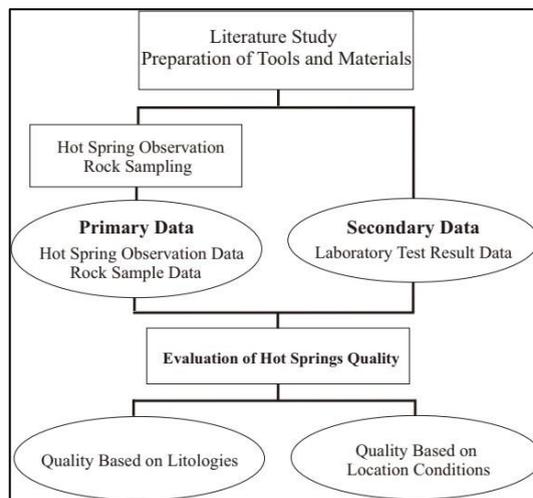


Fig. 1. Method Flow Chart

2.1 Primary Data

The primary data obtained in this research is hot spring observation data and data from rock samples in the research area obtained from activities in the form of observing the research location and taking rock samples in the field.

Hot Spring Observation Data. In observing hot springs, several activities are carried out such as observing hot spring pools, documenting the research location as evidence and supporting data from laboratory test data and recording conditions at the observation location such as land use, vegetation and weather.

Rock Sample Data. Rock samples were taken at the research location at 6 points in the research area, 2 of which were near the hot spring location. This rock sampling was carried out to determine the relationship between the lithology constituents and the content in the hot water at the research location

2.2 Secondary Data

Write Subsection using italic format followed by normal format content. Secondary data used in this research is data from Laboratory Test Results in 2022 whose samples were taken directly by the East Kalimantan Mineral Resources Energy Service. This data is then searched for the threshold for each parameter based on the Republic of Indonesia Health Government Regulation Number 32 of 2017 [3].

3 Results

In this research, laboratory testing was carried out on water samples taken at the research location. This test was carried out by the Health Laboratory of East Kalimantan, where this test included physical and chemical tests which are presented in Table 1.

Table 1. Laboratory Test Result and Limits

Parameter	Unit	Test Result	Limit
Temperature	°C	43	15-40
pH	-	6.49	5-9
Iron (Fe)	mg/L	0.0118	1
Cadmium (Cd)	mg/L	0.00342	0.005
Hardness (CaCO ₃)	mg/L	782.2	500
Zinc (Zn)	mg/L	0.075	15
Sulfate (SO ₄ ²⁻)	mg/L	55.296	400
Lead (Pb)	mg/L	<0.0016	0.05

3.1 Hot Springs Quality Based on Lithologies

The first lithology obtained was around the research location, specifically the entrance and back of the Danum Layong hot springs. The distance between the lithology observation location and the hot spring location is approximately ± 50 meters each. The lithology obtained is limestone (Fig. 2) and (Fig. 3.). The main mineral in limestone is calcite. The formation of calcite in limestone begins with the mineral aragonite, which is a metastable mineral because over a certain period of time it can change into calcite. This makes the Hardness (CaCO_3) value from laboratory tests high (Table 1.) and exceeds the maximum limit.

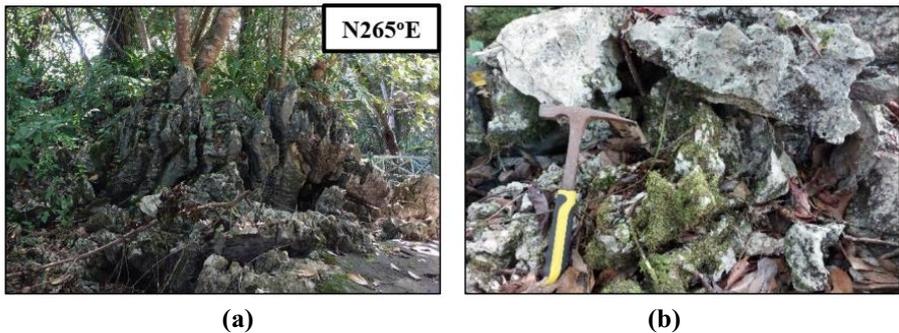


Fig. 2. (a) Outcrop, (b) Lithology Sampel. The Figure Is Documentation with The Photo Direction $\text{N}265^\circ\text{E}$ The Lithology Is Found Is Limestone. Source: Personal Documentation



Fig. 3. (a) Outcrop, (b) Lithology Sampel. The Figure Is Documentation with The Photo Direction $\text{N}10^\circ\text{E}$ The Lithology Is Found Is Limestone. Source: Personal Documentation

The limestone obtained is a lithology with a type of non-clastic sedimentary rock, has a fresh grayish white color with a massive structure, the rock texture is amorphous, and the composition is monomineralic CaCO_3 .

Variations in geographic and geological factors can cause significant differences in the physical and chemical parameters of hot springs. Analysis of chemical characteristics shows that sulfate (SO_4^{2-}) are below the maximum threshold according to the Republic of Indonesia Health Government Regulation Number 32 of 2017, even though

the measured water pH value is 6.49 close to neutral. This is caused by the limestone lithology which is rich in CaCO_3 in the bathing area. According to Mauren et al., the increase in pH can be influenced by temperature and the amount of CaCO_3 in the water. (Table 1) shows that the hardness (CaCO_3) and temperature of the hot water exceed the threshold, which contributes to a nearly neutral pH value, making it safe for use as a bathing location [4].

Apart from limestones around the hot springs, there are also several lithologies found around the research area, namely mudstone (Fig. 4), siltstone (Fig. 5) and sandstone (Fig. 6) (Fig. 7). The distance of each lithology is also different, for mudstone lithology it is around ± 3.8 km, siltstone lithology is ± 3.6 km and sandstone lithology is around ± 1.2 km and ± 5.6 km from the research location.

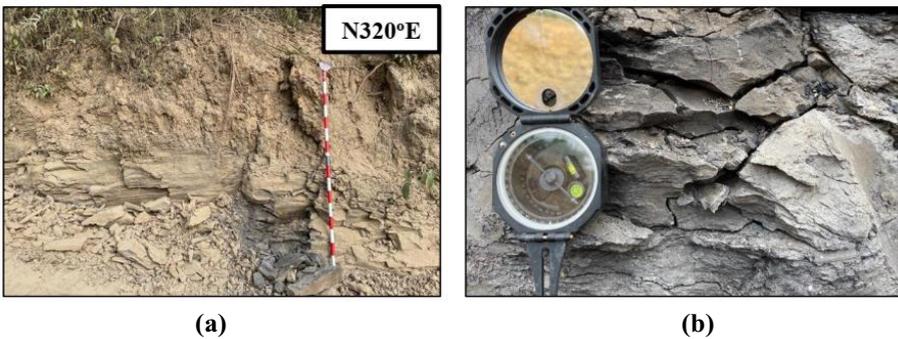


Fig. 4. (a) Outcrop, (b) Lithology Sampel. The Figure Is Documentation with The Photo Direction N320°E The Lithology Is Found Is Mudstone. Source: Personal Documentation

The mudstone obtained is a lithology with a type of clastic sedimentary rock, has a fresh grayish color, a weathered brownish color. The grain size is clay (<0.004 mm), the degree of rounding is very rounded, the degree of sorting is very good, and it has a closed packing. This lithology has a bedding structure with a composition of clay mineral matrix, silica cement (non-carbonate) without fragments.

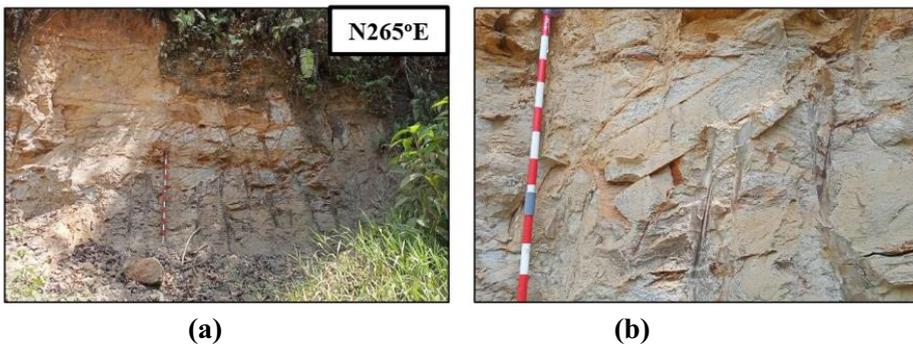


Fig. 5. (a) Outcrop, (b) Lithology Sampel. The Figure Is Documentation with The Photo Direction N265°E The Lithology Is Found Is Siltstone. Source: Personal Documentation

The siltstone obtained is a lithology with a type of clastic sedimentary rock, has a fresh grayish color, a weathered brownish orange color. The grain size is silt (0.06–0.004 mm), the degree of rounding is rounded, the degree of sorting is good, and it has a closed packing. This lithology has a massive structure with its composition consisting of a mineral matrix of silt, silica cement (non-carbonate) and iron oxide without any fragments.

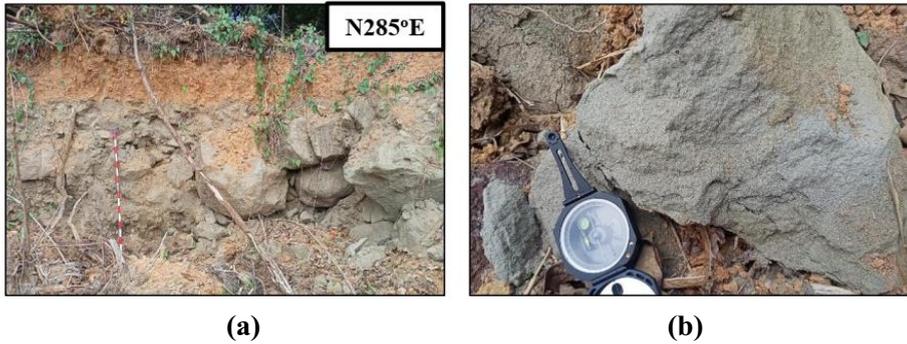


Fig. 6. (a) Outcrop, (b) Lithology Sampel. The Figure Is Documentation with The Photo Direction N285°E The Lithology Is Found Is Sandstone. Source: Personal Documentation

The sandstone obtained is a lithology with a type of clastic sedimentary rock, has a fresh grayish color, a weathered brownish color. The grain size is medium sand (0.50-0.25 mm), the degree of rounding is rounded, the degree of sorting is good, and it has an open packing. This lithology has a bedding structure with its composition consisting of a silica cement sand (non-carbonate) mineral matrix without any fragments.



Fig. 7. (a) Outcrop, (b) Lithology Sampel. The Figure Is Documentation with The Photo Direction N82°E The Lithology Is Found Is Sandstone. Source: Personal Documentation

The sandstone obtained is a lithology with a type of clastic sedimentary rock, has a fresh grayish color, a weathered brownish orange color. The grain size is fine sand (0.25-0.125 mm), the degree of rounding is rounded, the degree of sorting is good, and

it has an open packing. This lithology has a massive structure with its composition consisting of a mineral matrix of silica cement sand (non-carbonate) and iron oxide without any fragments.

The minerals that generally make up these lithologies are quartz and feldspar, only the amount of quartz and feldspar in mudstone is not as much as in sandstone. The low content of heavy metals such as Fe, Zn, Cd and Pb in hot water indicates that there is no influence from volcanic activity, so that the concentration of metal ions is also low and causes the pH to remain stable, approaching neutral, in accordance with the statement of Sukoasih [5]. This makes hot water safe for health therapy and bathing because it does not contain dangerous contaminants that can affect pH and overall water quality.

3.2 Hot Springs Quality Based on Location Conditions



Fig. 8. (a) Conditions Around the Bathing Location, (b) Hot Springs Pool

The situation around the bathing location which is still surrounded by forest makes the bathing location look shabbier and more unkempt, apart from that, the absence of a cover on the hot springs pool causes damage to the quality of the hot water from a physical and chemical perspective.



Fig. 9. (a) Hot Springs Pool Conditions, (b) Brige Condition.

The bathing pool at the research location shows inadequate condition, as can be seen from the water being dirty due to a lot of pollution and the lack of new water replacement after use. Apart from that, accommodation infrastructure such as the main bridge which is damaged and not maintained also worsens the overall condition.

4 Discussion

Judging from the state and condition of the pool and accommodation at the location, it can be concluded that the quality of the hot water based on the conditions of the bathing location is classified as inadequate. This can be changed if there is reconstruction and improvement at the bathing location.

5 Conclusions

Based on the analysis of the lithological aspect and the condition of the research location that has been carried out, the lithological aspect has the result that the research location is suitable as a means of bathing and the condition aspect of the research location has the result that it is not suitable. So, it can be concluded that the Danum Layong hot spring's location is declared suitable as a bathing and soaking location with several considerations such as repair and reconstruction of the location.

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