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Geological Mapping and Spring Water Quality Analysis in Mehara Village, Tutuala Administrative Post, Lautém Municipality

Juvencio Dos Santos*, Ricardo Gome, Igildo Dos Santos, Abrão Luis A. da L.Guterres, Gregorio da Costa Ribeiro, Juvinal X. Guterres
Universidade Oriental Timor Lorosa'e, Timor-Leste
Email: santossefoe@gmail.com*

Abstract:
The study area for the final project is located along the east coast of Timor Island, within the Lautém municipality, specifically in the post-administrative region of Tutuala, Village of Mehara, with coordinates 127° 9' 0'' E - 127° 12' 0'' E and 08° 22' 30'' S - 08° 25' 30'' S, covering a total area of 6 x 6 km (36 km²). The research area consists of two lithological units: massif coral siltstone and coral sandstone. The lithology types present in the study area indicate three different geomorphologic units: lagoon, karst morphogenesis unit, and fluvial morphogenesis unit. There are three springs: Ira Veru spring, Ira Masi spring, and Lagoon Ira Lalaru, which are permanent water sources used to analyze physical, chemical, and bacteriological parameters. According to laboratory tests on water quality from the collected springs, the physical and chemical properties are within normal ranges; however, the bacteriological parameters show a high presence of coliform microbes, including E. coli. The presence of these microbes in the water affects the quality of groundwater and influences the degree of contamination in drinking water. The type of contamination present in the water is both punctual and diffuse, which impacts community life.

***Keywords**: Geology, Geomorphology, Hydrogeology, Quality water*

INTRODUCTION

Geological mapping is a geological survey conducted as a specific study of surface activities and operations, aimed at applying geological knowledge necessary for the construction of a geological map (Ferreira, 2011). Generally, this study seeks to understand geological information in the field, integrating various related disciplines such as geology, hydrology, petrology (lithology), geomorphology, environmental geology, geological structures, and stratigraphy (Audley-Charles, 2011). These areas of knowledge form the fundamental basis for geologists when conducting field research (AG NHMRC, 2017).

Today, geological mapping is an intensive and indispensable method, especially with the integration of modern technologies in the global era, contributing to sustainable development in economic, environmental, and social aspects within a nation. It also supports political decision-making for managing resources such as water, minerals, and industrial rocks (Mustafa & Taylor, 2011).

In the context of environmental planning and territorial management, geological mapping is important for preventing risks related to natural contamination (Costa, 2013). One notable geological mapping study in Timor-Leste was published by experts Azeredo Leme and Audley Charles in 1968.

Lautém is one of the eastern municipalities of Timor-Leste, particularly in the *Tutuala Administrative Post*, *Mehara Village*, located at the easternmost point of Timor Island. It is also recognized as a tourist hub due to its distinctive landscapes, including the *Ira-Lalaru Lagoon* and the *Nino Konis Santana National Park*, and is a center for education, health, and infrastructure (Bear & Cheng, 2010).

The distribution of water in urbanized areas is unequal and does not always meet the diverse needs of communities. In Lautém municipality, particularly in *Tutuala Administrative Post* and *Mehara Village*, the water supply is sourced from underground resources, primarily from the Baucau karst aquifer (Duffy, 2012b). This aquifer is known for its permeable carbonate materials formed through geological processes that include the presence of caves and various water-emitting springs (Duffy, 2012a).

Groundwater is considered an alternative and reliable water resource for sustaining human life due to its quality and potential. The global community, including the people of Timor-Leste, rely on such water sources for daily consumption.

Groundwater quality is influenced by geological factors, especially its physical, chemical, and bacteriological properties. It can also be affected by human intervention in industrial, agricultural, construction, and infrastructural areas.

Therefore, from a geological perspective, assessing the quality of spring water is essential for human life. As a researcher, this final project is developed under the title: "Geological[A1] Mapping and Spring Water Quality Analysis in *Mehara Village, Tutuala Administrative Post, Lautém Municipality*."

This monograph is written with the specific intent to fulfill one of the academic requirements for engineering studies in the Department of Geology, Faculty of Engineering, at the Oriental University of *Timor Lorosa'e*.

RESEARCH METHODS

The research method employed a combination of cartographic (mapping) and geological study approaches, beginning with a bibliographic review and secondary data collection, followed by fieldwork, laboratory analysis, and inductive reasoning. The inductive method involved observation, hypothesis formulation, experimentation, and verification to explain geological phenomena in the the[A1] study area. The field phase included equipment-based data collection (e.g., GPS, compass, hammer, sample containers) and activities such as mapping, observing lithology and structures, describing features, and collecting rock and water samples. The laboratory phase focused on petrographic analysis, thin section preparation, and testing water quality based on physical, chemical, and bacteriological parameters. The final stage was the compilation of a scientific report, synthesizing all findings from field and laboratory work to produce a detailed hydrogeological and geological map of the study area in *Timor-Leste*.

RESULTS AND DISCUSSION

Standardization of water quality is based on areas that benefit from each water spring. The analysis of groundwater quality is also compared to WHO, (2011) laboratory standards to ensure it meets water needs. The laboratory results cover parameters that analyze the characteristics of groundwater, including physical, chemical, and bacteriological parameters according to international standards (Furness, 2012a; Furness, 2012b).

Surface runoff water that infiltrates underground becomes spring water (outlet) (Furness, 2015). The emergence of spring water reflects the hydrogeological conditions in the study area. The identified springs are as follows: Ira Veru Spring, referred to as a perennial spring (flowing throughout the year), Ira Masi Spring, and Lake Ira Lalaru (Lagoon Ira Lalaru). Calcarenite and calcilutite, originating from limestone, form layers of rock with potential permeability to store and support water. Their fragile structure allows for easy dissolution, triggering karstification when in contact with water, creating water flow and storage. Over time, limestone can dissolve and form caves, dolines, and uvalas. Therefore, limestone is considered a type of karst aquifer. This limestone unit is dominant in the study area, extending from east to south and north. According to Audley Charles (1968), the Baucau limestone can reach up to 500 m in thickness, interpreted as a double-thick layer with topographic conditions characteristic of karst aquifers.

Ira Veru Spring

The spring located in the Mehara village area, situated along the northeastern coast of the research area, has coordinates of 08°23’30’’S, 127°10’57’’E and an elevation of 522 meters above sea level. The observed water source appears to originate from calcilutite limestone, with physical characteristics showing a pH of 8.1. The final results indicate good quality based on international standards, with conductivity measured at 685 µS/cm, temperature at 24.8°C, TDS at 343, salinity at 0.3, and turbidity at 3.4. This water source serves the entire Mehara community and surrounding areas. It is used for residential consumption, schools, the village administrative post, and various other purposes such as household cultivation, gardens, rice fields, animal husbandry, and construction activities (Haig & Keep, 2012).

Figure 1. Ira Veru Spring, Laboratory Analysis Source: (Juvencio, 2020).

Table 1. Test Results of Physical, Chemical, and Bacteriological Parameters of Water Quality from Ira Veru Spring, Source: (Juvencio, 2020).

Sample analysis reference : **000006508**

Requesting Organization : **UNITAL**

Description of the organization: **DEP. GEOLOGIA**

Contact Person : **Mr. JUVENCIO DOS SANTOS** | Telephon : **76108920**

On behalf of organization, I agree to pay the cost of test request below: Signature: √

Data and time sample was taken : **25 / 10 / 2019** | Date and Time sample was received: **05 / 11/ 2019**

Sample location specification : **MEHARA (IRA VERO)**

Water Source: | River √ | Mountain stream | Spring | Well | Others

Sampled by : **Mr. JUVENCIO DOS SANTOS** | Received in laboratory by: **ESTELA SALDANHA**

Approved to test by: **ESTELA SALDANHA**

Cost (US$)	Parameter	Unit	Request test	Result	WHO/East Timor Guideline	Testing method
Physical test						
1.00	pH value	-	√	8.1	6.5-8.5	pH Meter
1.00	E.Conductivity	(µs/cm	√	685	NS	Conductivity meter
1.00	TSS	(mg/L)	X	NT	NS	Gravimetry
1.00	TDS	(mg/L)	√	343	1000	Gravimetry
1.00	Salinity	(‰)	√	0.3	NS	Conductivity meter
1.00	Temperature	(℃)	√	24.8	NS	Conductivity meter
1.00	Turbidity	NTU	√	3.4	5 (NTU)	Turbidity meter
Chemical test						
2.00	NH_3-N	mg/L	√	**2.9**	1.5	Spectrophotometer
2.00	NO_3-N	mg/L	√	0.4·	10 (as NO_3-N)	Spectrophotometer
2.00	NO_2-N	mg/L	√	0.012	1 (as NO_2-N)	Spectrophotometer
1.00	Iron (Fe)	mg/L	√	0.21	0.3	Spectrophotometer
2.00	Manganese (Mn)	mg/L	√	0.0	0.5	Spectrophotometer
1.00	Fluoride	mg/L	√	1.25	1.5	Spectrophotometer
2.00	Free chlorine	mg/L	√	0.0	0.5	Comparator,
2.00	Ca.hardness	mg/L	√	200	NS	Titration
2.00	Arsenic	mg/L	X	NT	0.01	Comparator
2.00	T. Hardness	mg/L	X	NT	200	Titration
2.00	Total alkalinity	mg/L	X	NT	NS	Titration
2.00	Sulphate (SO_4^{2-})	mg/L	√	13	250	Spectrophotometer
Bacteriological test						
16.00	Total Coliform	CFU/100mL	√	**17**	0	Membrane filtration
16.00	E.Coli	CFU/100mL	√	**5**	0	Membrane filtration
	Total cost	Remark				
	$. 54.00 USD	**- Bacteriological is problem !** **- NH_3-N is high !**				**Inspected by:** **Chief of DNSA Laboratory**

Legend: 1. **NS**: not set; **ND**: not detectable; **NT**: not tested; **NR**: not result; **CFU**: Colony

Water Quality Potential

The spring water quality identified is not the same as after laboratory testing. According to Thomad C. Winter et al. (1998), "water quality depends on its use and the different types of sources, which may come from community, municipal, industrial, agricultural, and domestic sources. These developments increase the concentration of water contamination." Thus, underground water contamination may occur as follows:

The water quality from Ira Veru Spring contains normal physical and chemical properties, but bacteriological properties include the presence of 17 coliform microbes and 5 E. Coli microbes (Sundawa, 2012). Therefore, this spring water is considered problematic in terms of microbiological contamination. These microbes come from unicellular or multicellular organisms, often resulting from human and animal behavior. The E. Coli count is quite high, whereas according to international standards, the value for bacteriological presence should be zero (0) to be safe for daily human consumption. Hence, this water is considered to have an impact on community health when consumed. In this area, residents who consume this water may require some form of treatment or medication to eliminate the microbes beforehand, so that it does not pose health risks (Simões, 2010).

Figure 2. Ira Veru Spring – Water Quality Potential, Laboratory Analysis Source: (Juvencio 2020).

Spring Water from Ira Masi (Ira Masi Spring)

The spring is located in the area of Hehara village, specifically in the Gelata area, situated on the northeastern coast within the study area at coordinates 08°23'57"S, 127°08'56"E, with an elevation of 538 meters above sea level. The water is observed to originate from limestone and has the following physical characteristics: a pH of 7.9, conductivity of 837 µs/cm, and a temperature of 24.0°C (Vilanova, 2011).

This spring provides water supply for all the communities in Suku Mehara and the surrounding areas. For those who consume water from this spring, it is used for various purposes such as home gardening, farming, floodplain cultivation, livestock watering, and construction activities.

Figure 3. Spring Water from Ira Masi (Ira Masi Spring) NE, Laboratory Analysis Source: (Juvencio 2020).

Table 2. Test Results of Physical, Chemical, and Bacteriological Parameters of Spring Water Quality from Ira Masi Spring Source: (Juvencio 2020).

Sample analysis reference : 000006509
Requesting Organization : UNITAL
Description of the organization: DEP. GEOLOGIA
Contact Person : Mr. JUVENCIO DOS SANTOS | Telephon : 76108920
On behalf of organization, I agree to pay the cost of test request below: Signature: √
Data and time sample was taken : 25 / 10 / 2019 | Date and Time sample was received: 05 / 11/ 2019
Sample location specification : MEHARA (IRA MASI)
Water Source: River | Mountain stream | Spring √ | Well | Others
Sampled by : Mr. JUVENCIO DOS SANTOS | Received in laboratory by: ESTELA SALDANHA
Approved to test by: ESTELA SALDANHA

Cost (US$)	Parameter	Unit	Request test	Result	WHO/East Timor Guideline	Testing method
Physical test						
1.00	pH value	-	√	7.9	6.5-8.5	pH Meter
1.00	E.Conductivity	(μs/cm	√	837	NS	Conductivity meter
1.00	TSS	(mg/L)	X	NT	NS	Gravimetry
1.00	TDS	(mg/L)	√	419	1000	Gravimetry
1.00	Salinity	(‰)	√	0.4	NS	Conductivity meter
1.00	Temperature	(°C)	√	24.0	NS	Conductivity meter
1.00	Turbidity	NTU	√	1.0	5 (NTU)	Turbidity meter
Chemical test						
2.00	NH_3-N	mg/L	√	5.4	1.5	Spectrophotometer
2.00	NO_3-N	mg/L	√	0.2	10 (as NO_3-N)	Spectrophotometer
2.00	NO_2-N	mg/L	√	0.005	1 (as NO_2-N)	Spectrophotometer
1.00	Iron (Fe)	mg/L	√	0.09	0.3	Spectrophotometer
2.00	Manganese (Mn)	mg/L	√	0.0	0.5	Spectrophotometer
1.00	Fluoride	mg/L	√	0.66	1.5	Spectrophotometer
2.00	Free chlorine	mg/L	√	0.0	0.5	Comparator,
2.00	Ca.hardness	mg/L	√	350	NS	Titration
2.00	Arsenic	mg/L	X	NT	0.01	Comparator
2.00	T. Hardness	mg/L	X	NT	200	Titration
2.00	Total alkalinity	mg/L	X	NT	NS	Titration
2.00	Sulphate (SO_4^{2-})	mg/L	√	24	250	Spectrophotometer
Bacteriological test						
16.00	Total Coliform	CFU/100mL	√	3	0	Membrane filtration
16.00	E.Coli	CFU/100mL	√	1	0	Membrane filtration

Total cost: S. 54.00 USD

Remark
- Bacteriological is problem !
- NH_3-N is high !

Inspected by:
Chief of DNSA Laboratory

The spring water from Ira Masi contains normal physical and chemical properties, and its bacteriological properties consist of 3 coliform microbes and 1 E. coli microbe.

The presence of coliform microbes in the spring water indicates a minor microbiological issue. These microbes originate from unicellular or multicellular organisms, often resulting from human activity or animal waste (Ximenes, Pratas, De Azevedo, Figueiredo, & Currell, 2025). The level of E. coli is relatively low; however, according to international standards, the acceptable bacteriological value for drinking water is zero (0). This is to ensure that the water is safe for daily human consumption. Therefore, the quality of this water has potential health impacts on the community (Ximenes, Pratas, De Azevedo, Figueiredo, & Currell, 2018).

When consumed, it is recommended that the community treat the water first with appropriate methods to kill the microbes before drinking it, in order to prevent health risks. (See Annex Photo II).

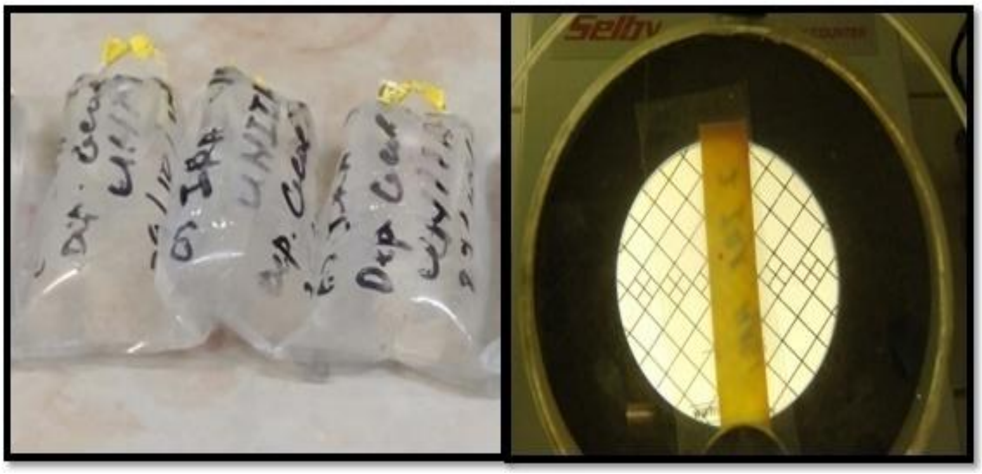

Figure 4. Spring Water from Ira Masi – Water Quality Potential, Laboratory Analysis Source (Juvencio 2020).

Lagoon Ira Lalaru (Ira Lalaru Lagoon)

The spring water is located in the area of Hehara village, along the northeastern coast, within the study area at the coordinates 08°25'38"S, 127°09'21"E, with an elevation of 380 meters above sea level (Ley, Munday, & Fitzpatrick, 2019). The water is observed to originate from limestone, with physical characteristics including a pH of 8.0, conductivity of 710 µs/cm, and temperature of 24.7°C. This water source supplies the entire community of Mehara village and its surrounding areas. For those who consume this spring water, the community uses it for washing clothes, and it also serves various other purposes such as gardening, irrigation, livestock, and construction needs (Wallace et al., 2012).

Figure 5. Lagoon Water from Ira Lalaru (NE), Laboratory Analysis Source (Juvencio 2020).

Table 3. Test of Physical, Chemical, and Bacteriological Parameters of Spring Water Quality from the Ira Lalaru Source, Source: (Juvencio 2020).

Sample analysis reference : 000006510
Requesting Organization : UNITAL
Description of the organization: DEP. GEOLOGIA
Contact Person : Mr. JUVENCIO DOS SANTOS | Telephon : 76108920
On behalf of organization, I agree to pay the cost of test request below: Signature: √
Data and time sample was taken : 25 / 10 / 2019 | Date and Time sample was received: 05 / 11/ 2019
Sample location specification : MEHARA (IRA LALARU)
Water Source: | River √ | Mountain stream | Spring | Well | Others
Sampled by : Mr. JUVENCIO DOS SANTOS | Received in laboratory by: ESTELA SALDANHA
Approved to test by: ESTELA SALDANHA

Cost (US$)	Parameter	Unit	Request test	Result	WHO/East Timor Guideline	Testing method
Physical test						
1.00	pH value	-	√	8.0	6.5-8.5	pH Meter
1.00	E.Conductivity	(µs/cm	√	710	NS	Conductivity meter
1.00	TSS	(mg/L)	X	NT	NS	Gravimetry
1.00	TDS	(mg/L)	√	355	1000	Gravimetry
1.00	Salinity	(‰)	√	0.1	NS	Conductivity meter
1.00	Temperature	(°C)	√	24.7	NS	Conductivity meter
1.00	Turbidity	NTU	√	0.8	5 (NTU)	Turbidity meter
Chemical test						
2.00	NH_3-N	mg/L	√	0.5	1.5	Spectrophotometer
2.00	NO_3-N	mg/L	√	1.0	10 (as NO_3-N)	Spectrophotometer
2.00	NO_2-N	mg/L	√	0.004	1 (as NO_2-N)	Spectrophotometer
1.00	Iron (Fe)	mg/L	√	0.05	0.3	Spectrophotometer
2.00	Manganese (Mn)	mg/L	√	0.0	0.5	Spectrophotometer
1.00	Fluoride	mg/L	√	0.70	1.5	Spectrophotometer
2.00	Free chlorine	mg/L	√	0.0	0.5	Comparator,
2.00	Ca.hardness	mg/L	√	325	NS	Titration
2.00	Arsenic	mg/L	X	NT	0.01	Comparator
2.00	T. Hardness	mg/L	X	NT	200	Titration
2.00	Total alkalinity	mg/L	X	NT	NS	Titration
2.00	Sulphate (SO_4^{2-})	mg/L	√	3	250	Spectrophotometer
Bacteriological test						
16.00	Total Coliform	CFU/100mL	√	**28**	0	Membrane filtration
16.00	E.Coli	CFU/100mL	√	**80**	0	Membrane filtration

Total cost: S. 54.00 USD
Remark: Bacteriological is problem !
Inspected by:
Chief of DNSA Laboratory

Legend: 1. NS: not set; ND: not detectable; NT: not tested; NR: not result; CFU: Colony

The water quality from the Ira Lalaru spring contains normal physical and chemical properties, but its bacteriological property consists of 28 Coliform microbes and 80 E. Coli microbes. The presence of Coliform microbes in the spring water indicates contamination by larger cellular microbes, which generally originate from unicellular or multicellular organisms, typically stemming from human and animal activities. The presence of E. Coli is also significantly high. According to international standards, the bacteriological value should be zero (0) in order to be considered safe and suitable for daily human consumption. Therefore, the presence of these microbes in the water has an impact on the health of the surrounding community. When the community consumes this water, they may need to treat it with certain remedies or purification methods to kill the microbes before drinking it, in order to avoid potential health implications (See Annex Photo III).

ChatGPT said:

Figure 6. Lagoon Water from Ira Lalaru — Water Quality Potential, Laboratory Analysis Source (Juvencio 2020).

CONCLUSION

The study was conducted in *Ponta Leste*, Timor Island, specifically in *Mehara Village*, *Tutuala Administrative Post*, *Lautém Municipality*. The area features three geomorphological units: fluvial, karstic, and lagoon formations. The stratigraphy comprises two main rock types: fine and coarse limestone, with a massive structure. Local communities use the rocks and water sources for building, farming, and gardening. Water quality analysis revealed that sources like *Lake Ira Lalaru* and springs *Ira Veru* and *Ira Masi* exhibit normal physical and chemical properties. However, high levels of microorganisms, particularly *E. coli*, were found in *Ira Veru* spring and *Lake Ira Lalaru*. *Ira Masi* spring[A1], with lower contamination, is still considered usable for daily community needs. The author recommends that relevant ministries, especially the Ministry of Environment, as well as communities and all Timorese citizens, use water wisely based on actual needs to avoid poor management. Since many communities still lack access to clean water, the government is urged to make greater efforts to address this issue, as water is essential for human life. The author welcomes readers' feedback and suggestions to help improve this geoscience final project, aiming for more constructive and refined outcomes in the future. Acknowledging that this monograph is not perfect, the writer hopes for readers' collaboration and support to enhance the quality and success of this work.

REFERENCE

AG NHMRC. (2017). Australian Drinking Water Guideline 6 2011. Australian Government, National Health and Medical Research Council, Level 1, 16 Marcus Clarke Street, Canberra.

Audley-Charles. (2011). Tectonic post-collision processes in Timor. Geological Society, London, Special Publications, 355, 241–266. https://doi.org/10.1144/SP355.12

Bear, J., & Cheng, A. (2010). Modeling groundwater flow and contaminant transport. Theory and Applications of Transport in Porous Media (Vol. 23). Springer, Dordrecht Heidelberg London New York. ISBN 978-1-4020-6681-8.

Costa, J. (2013). Recursos minerais de Timor-Leste. Rocha mãe e reservatório de hidrocarboneto (Formação de Aituto e Formação de Wailuli). Universidade de Évora, Engenharia Geológica, Exploração de Georrecurso.

Duffy, B. (2012). The structural and geomorphic development of active collisional orogens, from single earthquake to million year timescales, Timor Leste and New Zealand. University of Melbourne, Australia.

Duffy, B. (2012). Sedimentology of the Batu Putih and Viqueque Formations and implications for the development of Timor. University of Melbourne, Australia.

Ferreira, F. (2011). The Aitutu Formation and associated units at Soibada, Timor-Leste: Potential source rocks for Timor Leste's petroleum system. Research Project SCIE4501-4504, Faculty of Natural and Agricultural Sciences, The University of Western Australia.

Furness, L. (2012). The hydrogeology of the Baucau Limestone in Timor-Leste. Water Resources and Climate Adaptation Advisor, National Directorate of Water Resources, Ministry of Infrastructure, Australia.

Furness, L. (2012). Vulnerability assessment of climate change impacts on groundwater resources in Timor-Leste. Australia Geoscience, GeoCat73844.

Furness, L. (2015, April). Climate risk and vulnerability analysis for Dili Urban Services Improvement Sector Project. ADB Contract 118314, Australia.

Haig, D., & Keep, M. (2012). Recent advances in reconstructing the pre-collision stratigraphy of Timor-Leste. Centre for Energy Geoscience, School of Earth and Environment (M004), The University of Western Australia, Crawley 6009, Australia.

Ley, Y., Munday, T., & Fitzpatrick, A. (2019). Integrating geophysical airborne and geological data to characterize karst aquifer at Baucau Plateau, Baucau Municipality-Timor-Leste. ResearchGate. https://doi.org/10.13140/RG.2.2.23584.46080

Mustafa, A., & Taylor, W. (2011). Groundwater quantity and quality management. Groundwater Management Technical Committee of the Groundwater Council of EWRI Environmental and Water Resources Institute (EWRI) of the American Society of Civil Engineers.

Simões, C. (2010). Calcário conquífero. Programa Inovação de Geologia, Portugal.

Sundawa, A. (2012). Geologi dan studi penyebaran litofasies batugamping Formasi Punung daerah Girikikis dan sekitarnya, Kecamatan Giriwoyo, Kabupaten Wonogiri, Provinsi Jawa Tengah. Program Studi Teknik Geologi, Fakultas Teknologi Mineral, Universitas Pembangunan Nasional "Veteran" Yogyakarta.

Vilanova, V. (2011). Cartografia e estrutura dos recursos minerais dos distritos de Díli e Manatuto: Implicações para a génese e exploração. Universidade de Évora, Escola de Ciências e Tecnologia. Dissertação.

Wallace, L., Sundaram, B., Brodie, R. S., Marshall, S., Dawson, S., Jaycock, J., Stewart, G., & Furness, L. (2012). Vulnerability assessment of climate change impacts on groundwater resources in Timor-Leste: Summary report. Geoscience Australia.

WHO. (2011). Guidelines for drinking water quality (4th ed.). World Health Organization, Geneva.

Ximenes, M., Pratas, J. A. M. S., De Azevedo, J. M. M., Figueiredo, F. P. O. O., & Currell, M. (2018). Initial observations of water quality indicators in the unconfined shallow aquifer in Dili City, Timor-Leste: Suggestions for its management. Environmental Earth Sciences, 77(21), 1–15. https://doi.org/10.1007/s12665-018-7902-8

Ximenes, M., Pratas, J. A. M. S., De Azevedo, J. M. M., Figueiredo, F. P. O. O., & Currell, M. (2025). Identification of hydrochemical processes and assessment of groundwater quality: A case study of the intergranular aquifer in Dili City, Timor-Leste. Geology, Ecology, and Landscapes. https://doi.org/10.1080/24749508.2025.2449622