
CHARACTERISTICS OF FORAMINIFERA DISTRIBUTION IN VOLCANIC TUFF OF PAREPARE TANAMAILIE PINRANG, SOUTH SULAWESI

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ABSTRACT

This research was conducted to determine and distribute foraminifera in vertical positions using measured stratigraphy. This research aims to analyze the distribution characteristics of foraminifera in the Parepare Tanmailie Pinrang volcanic tuff, South Sulawesi. This research was conducted in the Tanamailie area in Suppa District, Pinrang Regency, South Sulawesi, where the fine-grained Parepare volcanics are well exposed. The method used in this research is field observation. The results of the research show that the analysis and description of fossils found in the measured stratigraphic landscape determined four sequential biozonations, namely from (1) The composition of the bottom layer in the N13 zonation *Sphaerodinellopsis* subdevices - *Globigerina* Drury, (2) The composition of the lower middle layer in the N14-N15 zonation *Globigerina* nepenthes - *Globorotalia* (T.) sickness to *Globorotalia* (T.) continuous, (3) Upper middle layer arrangement zonation N16-N18 *Globorotalia* (T.) *acostaensis* *acostaensis* - *Globorotalia* (G.) *merotumida* to *Globorotalia* (G.) *tumi-da* *plesirotumida* – *Sphaerodinellopsis* subdevices *paenedehiscens*, (4) Top layer composition of zonation N18-N19 *Globorotalia* (G.) *tumi-da* – *Sphaerodinellopsis* subdevices *paenedehiscens* to *Sphaerodinellopsis* *dehiscens* *dehiscens* - *Globoquadrina* *altispira* *altispira*. Analysis of abundant benthic foraminifera. This tough paleoenvironment is characterized by an abundance of *Textularis* sp and *Nodosaria* sp, indicating a shallow marine depositional environment.

Keywords: fossils, biozonation, paleoenvironment, volcanic.

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INTRODUCTION

Sulawesi Island is a volcanic arc extending from Sumatra, Java, and Nusa Tenggara continuously north to Sulawesi and Halmahera, the Philippines, Japan, and other neighboring countries (Andini, 2019). This volcanic arc is a path of tectonic order as a result of the subduction of one plate by another plate, as an implication of Indonesia's location at the meeting point of three plates, namely the Eurasian plate, the Pacific plate, and the Indo-Australian plate (Triana, 2017).

The age and depositional environment of volcanic rocks can be analyzed to determine and predict pyroclastic lithofacies, which are exposed in the research area consisting of pyroclastic flow deposits, namely volcanic clastic lithic tuff (Ramadhani, 2021). Volcanic rocks such as lava facies, agglomerates, and Parepare volcanic breccia have previously been studied as medial facies (Tania et al., 2020). Volcanic stratigraphy can provide an understanding of volcanic succession for predictions, especially in reconstructing past behavior. It is essential for identifying its relationship with volcanic products and sedimentary basins where the volcanism occurred (Nugraheni, 2019).

This research was conducted to determine how the biofacies are distributed vertically and the paleoenvironment of the Tanamailie Parepare volcanic tuff. Determining volcanic biofacies is a grouping to determine the vertical sequence of events so that volcano stratigraphy can produce

information and explain the geological history of volcanoes and be understood as a geological order (Relindo, 2021).

Based on the background above, this research aims to analyze the distribution characteristics of foraminifera in the Parepare Tanmailie Pinrang volcanic tuff, South Sulawesi. The benefits of this research are as an environmental assessment, namely as the distribution of foraminifera in volcanic tuff, can be used as an indicator of environmental conditions and changes in the past, assisting in environmental assessment and geological studies, and as an ecological insight, namely this research can provide valuable insight into the history of geology and processes that have shaped the South Sulawesi region, contributing to the broader field of earth sciences.

METHOD

This research consists of several stages: literature review, field survey, laboratory analysis, and interpretation. Field observations and measurable stratigraphic measurements include identifying the characteristics of each rock layer in the form of lithology, sedimentary structure, relationships between rock layers, rock mineral content, fossil content, and geometry (upright and flat), taking rock samples. The laboratory analysis carried out is micropaleontological analysis to identify the characteristics of each type of fossil, age, and depositional environment, which is then used for facies analysis, facies associations, and depositional environment as well as the development of the Parepare volcanic sediment deposit. Interpretation and reconstruction of basin development are carried out using data collected and assisted by the results of previous research such as regional geology, biostratigraphy, and the relationship of rock outcrops and residual soil with other rocks or minerals in the surroundings, as well as geological elements found in the field recorded visually through the digital camera; the sample is then prepared for laboratory analysis.

Surface data was collected on the Measured Stratigraphic stretch, rock data collection, and field descriptions. Samples were taken in layers representing the top, middle, and bottom, which are considered to represent each thickness in the field. Rock samples are also analyzed to determine the mineral content and chemical composition.

The research location is located in the Tanamailie area, Suppa District (Figure 1), Pinrang Regency, and is astronomically located at 119°35'45" East Longitude (East Longitude) and 4°0'45" South Latitude (South Latitude). This area was chosen because it is one of the best outcrops of Parepare volcanic tuff, where the rocks can be measured stratigraphically and contains abundant fossils with large fossil sizes. Suppose you cross via Parepare Beach to Tanjung Tanamailie using a boat. In that case, the distance that can be covered is much shorter compared to using the road. Link between Pinrang Regency and Pare-pare City. This area is summarized in the Western Part of Pangkajene and Watampone Sheet Map, South Sulawesi, scale 1:250,000, and the Earth Map of Indonesia, scale 1:50,000 published by the National Survey and Mapping Coordinating Agency (Geology & Sukanto, 1982).

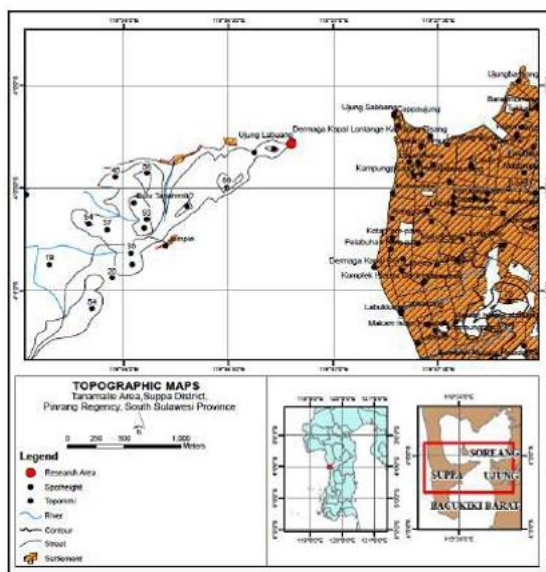


Figure 1. Map of research locations sources; Indonesian Earth Map

Geomorphology

Parepare is one of the cities that is developing towards the metropolitan capital in South Sulawesi, where the city is bordered on the east by hills that extend from North to North West as mountains through Pinrang, Parepare, Pangkajene, continuing to the western part of Watampone. This mountain range is bordered to the east by the Walanae Valley and the Walanae Terban as a ridge of mountain ranges that runs through Pinrang to Watampone. The highest peak of the western mountains is 1694 meters above sea level, and the average height is 1500 meters above sea level.

The distribution of the eastern mountains is half the Parepare area, 22 km long, narrowing in the north and widening 50 km to the south. Volcanic rocks dominate the rocks that make up this area. In several places, some of it is composed of limestone in the form of Kras, spreading on the eastern slopes, revealing the Kras topography. Some of the hills between the Kras topography are composed of Pre-tertiary rocks, found to the west, bordered by the Pangkajene plains, continuing towards the wide Maros to the south.

The eastern part of the highest peak is 700 meters, and the highest is 787 meters above sea level and extends relatively narrower and lower; these mountains are composed of volcanic rock. To the north, it narrows and becomes flatter, continues towards the south with a continuous height of 20 km wide, and finally dips below the boundary between the Waianae Valley and the Bone Plain. The Bone Plain extends to the northeast, occupying almost the eastern third. In the middle of the mountains is the Waianae Valley as a divider, extending from North to South, widening in the north to 35 km, and the south, narrowing to only 10 km. In the middle of the Walanae Terban, the Walanae River flows north-south, flanked by low hills as an alluvial plain that continues north to Sengkang and extends around Lake Tempe.

Stratigraphy

The spread of volcanic rocks covers the eastern part of Sidrap Regency and the northern part of Barru Regency. It spreads to cover Parepare City to Pinrang Regency. This land continues to the cape in front of or opposite the city of Pare-pare.

Pare-pare volcanic rocks consist of breccia and volcanic conglomerate and lapilli tuff and fine-grained tuff, some of which are found interbedded with lava and tuff sandstone composed of trachyte and andesite; the tuff layer contains much biotite; Generally, the wear is weak and some are crumbly, the color is grayish white to gray, some layers appear to have a cross-layered structure and traces of vegetation. This unit has a thickness of 500 m, is located on top of the Camba Formation rocks, and is interpreted to be at the top of the Walanae Formation of Pliocene age, from absolute method analysis of trachyte and tuff from northeastern Parepare (Majene-Palopo et al.) (Nainggolan, 2021).

The regional stratigraphy of the youngest sequence is spread around Parepare in the form of alluvium silt deposits, sandy mud exposed along large rivers, lake deposits around Lake Tempe's curve, and beach deposits consisting of gravel and clay along the coast. Local beach deposits contain shell remains and coralline limestone (Qc). Inserts of marine clay containing mollusks (Arca et al.) and iron peaks are found around Lake Tempe. Rocks of Pleistocene age (unmapped) in the form of exposed river steps in Sompoh Village, there are *Archidiscodon celebensis* as ancient elephant bones found near the Walanae River (Nainggolan, 2021).

The Parepare Volcanic Unit with the symbol (TPPV) Tertiary Pliocene Parepare consists of fine-grained volcanic rock to lapilli. In several places, volcanic breccia contains lava inserts and volcanic conglomerates. Petrographic analysis in the form of trachyte and andesite, as well as tuffaceous sandstone. Fine volcanic rock outcrops as tuff layers contain much biotite; generally wear weak and some crumbly; grayish white to gray. Locally, criss-cross layers and plant remains are visible.

Part of the rock, this volcano in the eastern area, consists mainly of Tertiary Pliocene Parepare Lava (Tppl), a trachyte structure containing much biotite (Sukur, 2022). This unit, estimated to be 500 m thick, overlies the rocks of the Camba Formation and possibly intersects with the upper part of the Walanae Formation. The age is Pliocene, based on radiometric dating of trachyte and tuff from northeastern Parepare (Majene-Palopo Sheet), which respectively gives 4.25 and 4.95 million years.

RESULTS AND DISCUSSION

Deposition on marina or land sediments with volcanic deposition is very different because the deposition rate is speedy and more complex (Aritonang et al., 2016). Agglomerate facies are exposed in Parepare City and Lumpue Beach. The fragments and matrix consist of trachytic monolithology. In the southern part, there are pumice deposits. In the upper part, they are covered by lava flows and ignimbrite deposits of various sizes of fume fragments (Bronto et al., 2014). Determining the age and analysis of the pyroclastic facies is still a matter of discussion because there are still differences of opinion regarding the age and depositional environment (Noor, 2014). Based on the fragments' texture, structure, and composition, the pyroclastic lithofacies consist of volcanic breccia facies and tuff facies (Figure 2). In the upper part, the lava lithofacies are divided into agglomerates in the Tonrangeng area, coherent lava, and autoclastic breccia, which are exposed both on Lumpue beach and volcanic breccia exposed in the Kupa area (Irfan et al., 2015).



Figure 2. Outcrop of the measured stratigraphic location of Tanamailie Pinrang

Facies Analysis Volcanic tufa exposed on Tanjung Tanamailie, fresh grayish white, weathered brownish gray, consists of alternations between relatively coarse and fine pyroclastic, carbonate in nature, the position of rock layers is N118oE/8o.

The biostratigraphy is based on the zonation of planktonic foraminifera, namely the initial appearance and final appearance of the characteristic species found in each layer (Alyara, 2021). The results of the analysis of the lower, middle, and upper layers, consisting of 4 continuous age periods in harmony from the upper Middle Miocene to the Pliocene (Table 1), are described as follows;

1. The first layer is the lowest part of the measured stratigraphy, consisting of alternating layers of fine tuff. The thickness of each layer is between 150 cm - and 200 cm, the coarser-grained tuff layer is between 10 cm and 150 cm, and the overall fine-grained tuff is thicker than the coarser stuff.

In this layer, planktonic fossils are found, which always appear in almost every layer, namely *Globigerinoides sub quadratus* BRONNIMANN, *Orbulina Bilobata* (D'ORBIGNY), *Globigerinoides immatures* LEROY, *Globoquadrina altispira* (CUSHMAN and JARVIS), *Globigeroides trilobus* (REUSS).

This zone is the oldest zone of the lowest layer based on the Early Appearance of *Globorotalia menardii* (D'ORBIGNY) to the Late Appearance of *Globigerinoides sub quadratus* BRONNIMANN, which is characterized by *Sphaeroidinellopsis subdevices* - *Globigerina Drury* Blow N13 zone, according to the Postuma age of the late Middle Miocene (RAMADHAN, 2018).

The second layer is the lower middle part of the measured stratigraphy consisting of alternating layers of fine tuff, the thickness of each layer is between 50cm – 230cm, the coarser grained tuff layers are between 20 cm – 150 cm each layer, the finer-grained tuff is overall thicker rather than coarser grain tufa. In this layer, it is located aligned above the lower middle layer; fossils found in this layer include *Globoquadrina dehiscence* (CHAPMAN, PARR, COLLINS), *Orbulina Bilobata* (D'ORBIGNY), *Globigerinoides sacculifer* (BRADY), *Globigerinoides sub quadratus* BRONNIMANN, *Globigerinoides immatures* LEROY, *Globoquadrina altispira* (CUSHMAN and JARVIS), *Orbulina universal* D'ORBIGNY.

This zone is the lower middle part based on the Late Appearance of *Globigerinoides sub quadratus* BRONNIMANN and the Late Appearance of *Globoquadrina dehiscence* (CHAPMAN, PARR, COLLINS), which is characterized by *Globigerina nepenthes* - *Globorotalia* (T.) sickness to

Globorotalia (T.) continuous Blow zonation N14-N15, According to Postuma, the age is Middle Miocene to Early Late Miocene.

- The third layer is the upper middle part of the measured stratigraphy consisting of alternating layers of fine tuff, the thickness of each layer is between 20cm – 70cm, the coarser grained tuff layers are between 45 cm – 160 cm each layer, the finer-grained tuff is overall thinner than tuff is coarser.

This layer is located in harmony above the lower middle layer, the fossils found include Globorotalia immatures LEROY, Globorotalia pseudomiocenica BOLLY and BERMUDEZ, Orbulina universal D'ORBIGNY, Globorotalia menardii (D'ORBIGNY), Globoquadrina dehiscens (CHAPMAN, PARR, COLLINS), Globorotalia Plesiotumida BLOW and BANNER, Orbulina Bilobata (D'ORBIGNY), Globigerina praebuloides BLOW.

This zone is based on the Early Appearance of Globorotalia pseudomiocenica BOLLI and the late emergence of Globoquadrina dehiscence (CHAPMAN, PARR, COLLINS) to the Late Appearance of Globorotalia Plesiotumida BLOW and BANNER, namely characterized by Globorotalia (T.) acostaensis acostaensis - Globorotalia (G.) merotumida to Globorotalia (G.) tumida plesiotumida – Sphaerodinellopsis subdehiscens paenedehiscens Blow zone N16-N18, according to Postuma the age is late Miocene to early Pliocene.

The fourth layer is the top part of the measured stratigraphy, consisting of alternating layers of fine tuff; the thickness of each layer is between 30cm – and 100cm. The coarser-grained tuff layer is between 10 cm and 110 cm, and the finer-grained tuff has a thickness almost the same as the coarser tuff.

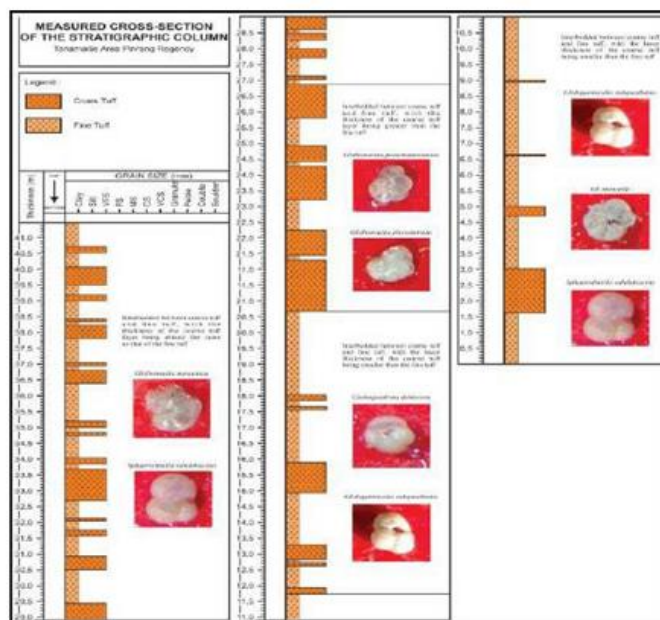


Figure 3. Tanamailie Stratigraphic Column

This layer is the top layer. The fossils found include Globorotalia menardii (D'ORBIGNY), Orbulina Bilobata (D'ORBIGNY), Sphaerodinellopsis subdehiscens BLOW, Globorotalia myogenica PALMER, Globigerinita naparimaensis BRONNIMANN, Globigerinoides sacculifer (BRADY), Orbulina universal D'ORBIGNY.

This zone is based on the Early and Late Appearance of the CUSHMAN and JARVIS Globorotalia miocenica index fossil, which is characterized by Globorotalia (G.) tumida – Sphaerodinelopsis subdehiscens paenedehiscens to Sphaeroidinella dehiscens dehiscens - Globoquadrina altispira altispira Blow N18-N19 zoning, according to the Pliocene Postuma (Iskandar et al., n.d.).

The depositional environment is characterized by abundant benthonic fossils (Figure 4). Textularilia sp Aphelis Loeblich and Tappan and Nodosaria, interpreted as indicating a shallow marine environment.

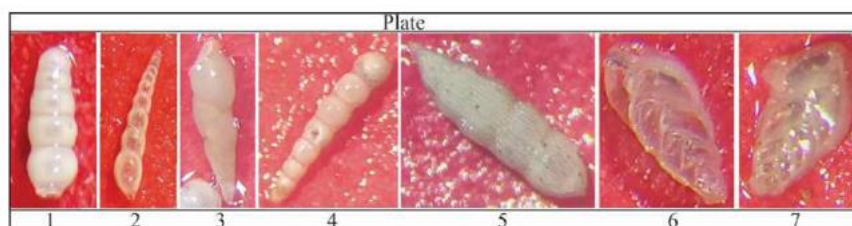


Figure 4. (Plate 1-5) Nodosaria ambigua and Nodosaria sp. (Plate 6-7) Laevidentalina aphelis Loeblich and Tappan and Textularia sp

CONCLUSION

Based on the results of the description of the fossil content and the age interpretation of the analysis results, which are represented by the lower layer and middle layer, and the upper layer where measured stratigraphy was carried out from the distribution of fossils, the age duration of N13-N19 or the last part of the Middle Miocene to the Pliocene is obtained. Deposited in an outer neritic to the inner neritic environment, based on abundant benthonic fossils found in almost all layers, namely Nodosaria sp. and Textularia sp. The fossil analysis provides an overview and shows that the volcanic tufa found in the Tanjung Tanamailie area is the lower part of the Parepare volcanic stratigraphic sequence.

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