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Elements of Metamorphic Rocks (Marble and Quartzite) of Bukit Cinta Gunung Gajah, Klaten

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Abstract: Rocks such as metamorphic and sedimentary are natural constructions. Rocks in natural construction become elementary materials that form the landscape of the area, including in nature-based tourism objects, Bukit Cinta in Gunung Gajah, Klaten, Central Java. The purpose of this research is to describe the elements of rocks in the place. The study method used is descriptive qualitative method and tends to use analysis. The theoretical basis is used as a basic reference in preparing the study report to match the conditions in the field. In addition, the theoretical basis can also provide an overview of the background of the study as material for discussion. The ability to collect data is an important factor in determining the validation of the study conducted. Data collection in this case is obtained secondarily, namely through documents or literature studies. The results of the study found that there are 3 main supporters for the strong landscape in the tourist ojek of Gunung Gajah love hill. The three are metamorphic rocks observed there are fillic metamorphic relief, marble metamorphic rocks, and quartzite metamorphic rocks; limestone sedimentary rocks. Limestone can be used for building materials, road paving, and house foundations; and Diorte igneous rocks. Diorte igneous rocks can be used as home decoration.

Keywords: Marble; Metamorphic; Quartzite; Rocks; Bukit Cinta

Introduction

Rocks as a combination of several substances that occur naturally may consist of minerals, pieces of rock and fossilised materials, such as shells or plants. All rocks on the surface of the Earth's surface come from magma that melts towards the surface. The temperature of the Earth's surface is much temperature is much lower than the temperature below the earth's surface resulting in the freezing of magma which forming rocks (Sari et al., 2018).

Gununggajah's village potentials are rock types and regional potentials. The rock types are metamorphic rocks, sedimentary rocks, and igneous rocks. Meanwhile, the potential of the area is motocross track, pencak silat pagar nusa, nyanting, Gununggajah weaving, laying ducks, horn bananas, nut bread, herbal medicine, and educational institutions. Gununggajah Village is a village with considerable development potential and diverse human resources. Geographically, Gununggajah village is located in Bayat sub-district, Klaten Regency, Central Java. Gununggajah is one of 18 villages in the Bayat sub-district. Gununggajah village is 5 km from the sub-district government centre, 18 km from the district, and 145 km from the province. The total area of Gununggajah village is 296.8585 hectares.

The boundaries of Gununggajah village are to the north, bordering Tawangrejo village. The south is directly adjacent to Dukuh Village. The west is bordered by Kebon village. The east is bordered by Tegalrejo village. Gununggajah village is located 164 m above sea level, making it have an average annual rainfall of 30.65 mm/year. The air temperature of Gununggajah village is in the range of 25-32 degrees Celsius. This condition makes Gununggajah village has cool mountain air and fog that often covers the village every morning. Village tourism in essence does not change what already exists in the community but rather to explore all the potential in the village by utilizing the ability of the elements in the village that function as tourism products and become

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a series of tourism activities and are able to provide also fulfil a series of what the needs of tourist travel both in aspects of attraction and as tourist support facilities.

This research will properly discuss the various rocks that exist in this landscape-based tourism area. Landscape-based tourism objects need to pay attention to the construction of supporting rocks so that the implementation of this tourism business is safe and effective. In addition, the environment where humans live also has different potential natural resources. Therefore, every human in different regions will have their own ways to process and utilize these natural resources (Suharta et al., 2023).

Method

This research is research using a qualitative approach (Rachmawan et al., 2022). This study uses a qualitative approach with qualitative descriptive methods to describe, describe and describe the learning needs of tourism-aware groups in the tourist cave of Tritis. Qualitative research in the field of education that was conducted by the researchers looked at the respondents as the subject, asked about something ordinary, collected data that mostly consisted of sentences emerging from the respondents, explained and analyzed the theme of the sentence, and conducted investigations in a more subjective manner (Creswell & Creswell, 2018).

The data collection techniques used included interviews with the experts of hills. Observations were also made to determine the truth of the answers provided by informant. Data collected in this study is qualitative data in the form of words or phrases that were obtained during the study. Qualitative data analysis was performed through data reduction procedures, data display, and conclusion drawing (Miles, 2015). As for the validity of data triangulation techniques, sources and methods will be used in this study.

Result and Discussion

The process of rock formation at Bukit Cinta

The formation of igneous rocks due to the cooling of magma (Azer & Asimow, 2021; Gill & Fitton, 2022). Rocks are solid aggregates formed by minerals that have solidified from natural processes (El Alami et al., 2020; Sultoni et al., 2019). Frozen rock is formed when magma from an erupting eruption of the volcano freezes on the surface or beneath the earth's surface (Caricchi et al., 2021). Group of igneous rocks found on the surface of the earth will come into contact with the atmosphere and hydrosphere which causes weathering process takes place Based on events or Based on their occurrence or mode of formation, rocks can be divided into three main groups, namely: Frozen Rocks, Frozen rocks are rocks which is formed due to the cooling and freezing of magma that occurs beneath the earth's surface or on the earth's surface. Revealed that "Frozen rocks are formed from the result of freezing magma or the crystallisation of minerals in the form of interlocking aggregations". Frozen rock is formed from magma which consists of liquids, gases, and crystals.

The placeor opening is called a crater or caldera, while the incandescent rock and gas is the magma. Rocks or volcanic deposits are solid materials in the form of rocks or deposits formed as a result of volcanic activity, either directly or indirectly (Hartono, 2007).

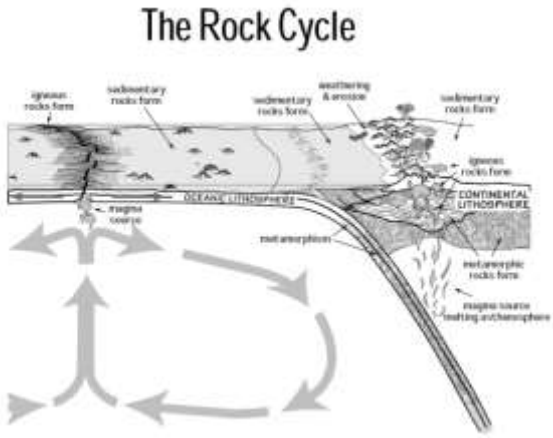

Figure 1. The Rocks Cylce Source: https://geologyscience.com

Rocks will undergo a crushing process. Furthermore, rocks that have been Next, the crushed rock will be moved or moved from where it was collected by gravity, water flowing above and below the surface, wind blowing, waves on the beach and glaciers in high mountains. These transporting media, also known as scrapers, attempt to level the Earth's surface. The materials it transports, whether in the form of fragments or soluble materials, will then be deposited in certain places as sediments (Syam, 2020).

The next process is the alteration of loose sediments, into hard rock, through loading and gluing by mineral compounds in solution, and then called sedimentary rock (Andò, 2020). If the sedimentary rock is subjected to increased pressure and temperature as a result of stockpiling and or involved in the process of mountain formation (El Alami et al., 2022), then the sedimentary rock will undergo changes to adapt to the new environment, and formed malihan rock or metamorphic rock. If this metamorphic rock is still subjected to increased pressure and temperature, it will melt again and turn into magma (Moreira et al., 2023). The rock cycle shows that the course of the cycle can be

interrupted by the existence of shortcuts that can be taken, such as from igneous rocks to metamorphic rocks, or metamorphic rocks to sediments without going through the formation of magma and igneous rocks. Sedimentary rocks, on the other hand, can again become sedimentary due to being exposed to the surface and undergoing a weathering process (Syam, 2020).

Rock Structure at Bukit Cinta

Gununggajah is a village with considerable development potential and diverse human resources. Geographically, Gununggajah village is located in Bayat sub-district, Klaten Regency, Central Java. Gununggajah is one of 18 villages in the Bayat sub-district. Gununggajah village is 5 km from the sub-district government centre, 18 km from the city/district, and 145 km from the province. The total area of Gununggajah village is 296.8585 hectares.

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The name Gununggajah was taken based on the history of the previous government system in the form of a kingdom. The mountain actually had a real elephant, but due to the magic of the King at that time, there was a mountain with an elephant. The king's prediction was that the village would develop in the future, meaning that the village would be crowded because of the attraction. The vision and mission of Gununggajah village was carried out in a participatory manner by involving parties such as the village government, BPD, community leaders, religious leaders, village community institutions and the people of Gununggajah village. The vision of Gununggajah Village is to realise a society that is toto titi tentrem karto raharjo. Meanwhile, the mission of Gununggajah Village is to create a safe village, to create a village of peace, tolerance in the midst of society between religious groups, and to create a prosperous community.

In nature, there are formations of various minerals and or formations of various elements which in this discourse are called rocks (Lubis, 2023). As for the outline based on how it is formed, the rock consists of the following:

Metamorphic rocks

Rock types in metamorphic rocks observed are fillic metamorphic relief, marble metamorphic rock, and quartzite metamorphic rock. Fillic metamorphic rocks can be used as electrical insulators and building materials (Pikovskiy et al., 2019), fillic metamorphic rocks are good at retaining heat. Marble metamorphic rocks can be used for floors and walls (dimension stone) (Bustillo Revuelta & Bustillo Revuelta, 2021). Marble metamorphic rocks in the observation location are only small in capacity and in the form of pockets, so they are not mined. Quartzite metamorphic rocks can be used for making glass, ceramics and jewellery (Dino et al., 2021).

Metamorphic rocks control groundwater, in that lithological aspects control groundwater distribution (Coyte & Vengosh, 2020; Pradhan et al., 2022). Metamorphic rocks do not have pores but have cavities or fractures to be filled with water so that they can store water. Metamorphic rocks can be changed physically or chemically to form a different rock under the high pressures and temperatures. Regional metamorphism refers to effects on large rock masses over a large area, usually associated with mountain formation events in orogenic belts. These rocks exhibit different bands of different mineralogy and colors, often called foliation. Another main type of metamorphism occurs when a rock mass comes into contact with an igneous intrusion that heats up this surrounding country rock.

This contact metamorphism results in an over temperature of the magma and a rock which is altered and recrystallized by the addition of liquids that add chemical material (metasomatism) to the surrounding rock. Any pre-existing rock species can be replaced by metamorphism processes. When a rock is exposed to extreme heat and pressure within the Earth but does not melt (Clemens et al., 2020), the rock becomes metamorphosed. Metamorphism can change the mineral composition and the texture of the rock. Thus, a metamorphic rock can be a new mineral composition and texture.

Sedimentary rocks

The type of rock found in the observations is limestone sedimentary rock. Limestone can be used for building mixes, road hardening, and house foundations (Golewski, 2023). Sedimentary rocks generally have pores to store water. However, the rocks owned by this tourist village are limestone sedimentary rocks that are difficult to store water. This is because limestone sedimentary rocks contain calcium carbonan minerals which are difficult to absorb water.

Rocks exposed to the atmosphere are variably unstable and subject to weathering and erosion (Phillips et al., 2019). Abrasion and erosion break down the

original rock into smaller pieces and remove dissolved materials. This shredded material accumulates and is embedded by additional material. While an individual sandstone is still a member of the rock class from which it is formed, it is a rock sediment composed of mixed grains. Sedimentary rocks may consist of collection of these small fragments (plastic clastic rock), accumulation and lithification of living organisms, or removal of mineral sediment from biologically deposited material. evaporation (sedimentary sedimentary rock). Due to processes such as plant residues, such as elastic or organic material, frangible fractions may form from fragments separated from larger rocks of any species. Biogenic and sedimentary rocks consist of accumulation of minerals from dissolved chemicals from all other rock types.

Erosion and Sedimentation: Attrition, rock glides into smaller pieces on the surface of the Earth (Freundt et al., 2023). Small pieces are called sediments. Flowing water, ice and gravity transport these deposits from one place to another by erosion. During sedimentation, sediments are laid or deposited. In order to form a sedimentary rock, the accumulated sediment must be compacted and cemented together. The different types of sedimentary rocks can be seen from the texture of the rocks and only geologists can classify them. Because the eye also has a level of accuracy in classifying objects, it is necessary to have an expert comparison tool to strengthen the classification of sedimentary rock types with relatively short time and high accuracy. In this final project, the author conducts research to design a classification system for sedimentary rock types based on texture (Fitri et al., 2017).

Igneous rocks

The type of rock found at the observation location on Gunung Gajah or Bukit Cinta includes diorte igneous rock. Diorte igneous rocks can be used as home decoration. In addition, diorte igneous rocks can one day form valuable metal deposits. Diorte is often associated with gold, copper and silver deposits. In Gunung Gajah or Bukit Cinta, a copper-bearing mineral called chalcopyrite was found.

The mineral composition of the petrographic analysis of the investigation area consists of the minerals muscovite, actinolite, chlorite, epidote, graphite, rutile, garnet, illite, kaolinite, silimanite and quartz, and has a slaty-schistose structure with abundant mica mineral content, indicating that the rock protolith is pelitic (Hasria et al., 2022). The volcanic rocks scattered around the study area, have unaltered conditions and those that have undergone low sulphide hydrothermal alteration. One of the hostrocks for mineralisation is pyroclastic rocks of Pliocene-Pleistocene age (Syah et al., 2020). Beside that, the vegetative strips of king grass, Guatemala, elephant grass, and Flemingia congesta (Syamsiyah & Dewi, 2014).

Figure 2. Bukit Cinta Rock Tourism Destination. Source: Author Property

When rocks are pushed deep under the surface, they can melt into magma. If the conditions for the magma to remain liquid are no longer present, they are cooled and incorporated into an igneous rock. A rock that cools in the earth is called intrusive or plutonic, and it cools very slowly to produce a coarse-grained texture, such as rock granite. As a result of volcanic activity, the magma (called lava when it reaches the Earth's surface), which is called extruded or volcanic rocks, can cool down very quickly while on the surface where the Earth is exposed to the atmosphere. These rocks are fine grained and sometimes so fast that no crystals form and do not result in a natural glass like obsidian, but the most common fine grained rock is known as basalt. Any of the three main rock types (igneous, sedimentary and metamorphic rocks) can melt into magma and cool down to igneous rocks.

The magma cools underground or on the surface and cures to a rickety rock (Odegaard, 2021). As the magma cools, different crystals form at different temperatures that undergo crystallization. For example, mineral olivine crystallizes at temperatures much higher than quartz than magma. The cooling rate determines how much time the crystals must form. Slow cooling produces larger crystals.

Conclusion

Landscape-based tourism is a necessity in this day and age. God's stone is also a material that invites potential to be empowered as a tourist attraction. Rocks display unique patterns and structures, so that they become a choice of amaliah material that can be fully enjoyed by humans. The results of the study found that there are 3 main supporters for the strong landscape in

the tourist ojek of Gunung Gajah love hill. The three are metamorphic rocks observed there are fillic metamorphic relief, marble metamorphic rocks, and quartzite metamorphic rocks; limestone sedimentary rocks. Limestone can be used for building materials, road paving, and house foundations; and Diorte igneous rocks. Diorte igneous rocks can be used as home decoration.

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References

Andò, S. (2020). Gravimetric separation of heavy minerals in sediments and rocks. *Minerals*, *10*(3), 273. https://doi.org/10.3390/min10030273

Azer, M. K., & Asimow, P. D. (2021). Petrogenetic evolution of the Neoproterozoic igneous rocks of Egypt. *The Geology of the Egyptian Nubian Shield*, 343–382. https://doi.org/10.1007/978-3-030-49771-2_13

Bustillo Revuelta, M., & Bustillo Revuelta, M. (2021). Dimension Stone. *Construction Materials: Geology, Production and Applications*, 55–90. https://doi.org/10.1007/978-3-030-65207-4_3

Caricchi, L., Townsend, M., Rivalta, E., & Namiki, A. (2021). The build-up and triggers of volcanic eruptions. *Nature Reviews Earth & Environment*, *2*(7), 458–476. Retrieved from https://www.nature.com/articles/s43017-021-00174-8

Clemens, J. D., Stevens, G., & Bryan, S. E. (2020). Conditions during the formation of granitic magmas by crustal melting--hot or cold; drenched, damp or dry? *Earth-Science Reviews*, *200*, 102982. https://doi.org/10.1016/j.earscirev.2019.102982

Coyte, R. M., & Vengosh, A. (2020). Factors controlling the risks of co-occurrence of the redox-sensitive elements of arsenic, chromium, vanadium, and uranium in groundwater from the Eastern United States. *Environmental Science & Technology*, *54*(7), 4367–4375. https://doi.org/10.1021/acs.est.9b06471

Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications, Inc.

Dino, G. A., Cavallo, A., Faraudello, A., Piercarlo, R., & Mancini, S. (2021). Raw materials supply: Kaolin and quartz from ore deposits and recycling activities. The example of the Monte Bracco area (Piedmont, Northern Italy). *Resources Policy*, *74*, 102413. https://doi.org/10.1016/j.resourpol.2021.102413

El Alami, K., Asbik, M., & Agalit, H. (2020). Identification of natural rocks as storage materials in thermal energy storage (TES) system of concentrated solar power (CSP) plants--A review. *Solar Energy Materials and Solar Cells*, *217*, 110599. https://doi.org/10.1016/j.solmat.2020.110599

El Alami, K., Asbik, M., Boualou, R., Ouchani, F., Agalit, H., Rachidi, S., & others. (2022). A critical overview of the suitability of natural Moroccan rocks for high temperature thermal energy storage applications: Towards an effective dispatching of concentrated solar power plants. *Journal of Energy Storage*, *50*, 104295. https://doi.org/10.1016/j.est.2022.104295

Fitri, D. B., Hidayat, B., & Subandrio, A. S. (2017). Klasifikasi jenis batuan sedimen berdasarkan tekstur dengan metode gray level co-occurrence matrix dan K-NN. *EProceedings of Engineering*, *4*(2). Retrieved from https://openlibrarypublications.telkomuniversity.ac.id/index.php/engineering/article/view/392

Freundt, A., Schindlbeck-Belo, J. C., Kutterolf, S., & Hopkins, J. L. (2023). Tephra layers in the marine environment: A review of properties and emplacement processes. *Geological Society, London, Special Publications*, *520*(1), 595–637. https://doi.org/10.1144/SP520-2021-50

Gill, R., & Fitton, G. (2022). *Igneous rocks and processes: a practical guide*. John Wiley & Sons.

Golewski, G. L. (2023). Effect of coarse aggregate grading on mechanical parameters and fracture toughness of limestone concrete. *Infrastructures*, *8*(8), 117. https://doi.org/10.3390/infrastructures8080117

Hartono, H. G. (2007). *Studi batuan gunung api pumis: Mengungkap asal mula Bregada gunung api purba di Pegunungan Selatan, Yogyakarta*. Institut Teknologi Nasional Yogyakarta. Retrieved from https://repository.itny.ac.id/id/eprint/2572/1/1

1_STUDI%20BATUAN%20GUNUNG%20API%20PUMIS%20MENGUNGKAP%20ASAL%20MULA%20BREGADA%20GUNUNG%20API%20PURBA%20DI%20PEGUNUNGAN%20SELATAN%2C%20YOGYAKARTA.pdf

Hasria, H., Idrus, A., & Wayan Warmada, I. (2022). Protolit Batuan Metamorf di Pegunungan Rumbia Kabupaten Bombana, Provinsi Sulawesi Tenggara, Indonesia. *Jurnal Geologi Dan Sumberdaya Mineral*, *23*(1), 25–33. https://doi.org/10.33332/jgsm.geologi.v23i1.638

Lubis, L. H. (2023). *Teori Dasar Fisika Bumi*. PT Cahaya Rahmat Rahmani.

Miles, R. (2015). Complexity, representation and practice: Case study as method and methodology. *Issues in Educational Research*, *25*(3), 309–318. Retrieved from https://www.iier.org.au/iier25/miles.html

Moreira, H., Dhuime, B., Ionov, D., Buzenchi, A., & Gusev, N. (2023). Hafnium isotope systematics of zircon in high-grade metamorphic rocks of the Anabar shield, Siberia: Radiogenic Hf without mantle input? *Chemical Geology*, *636*, 121644. https://doi.org/10.1016/j.chemgeo.2023.121644

Odegaard, K. (2021). *A Study of Crystallinity in the Blue Dragon Lava Flow and the Ross Flow Using Visible Near-Infrared Spectroscopy*. University of Idaho.

Phillips, J. D., Pawlik, Ł., & Šamonil, P. (2019). Weathering fronts. *Earth-Science Reviews*, *198*, 102925. https://doi.org/10.1016/j.earscirev.2019.102925

Pikovskiy, Y. I., Ismailov, N. M., & Dorokhova, M. F. (2019). *Oil and Gas Enviromental Ecology*. Academus Publishing Campbell, CA, USA.

Pradhan, R. M., Singh, A., Ojha, A. K., & Biswal, T. K. (2022). Structural controls on bedrock weathering in crystalline basement terranes and its implications on groundwater resources. *Scientific Reports*, *12*(1), 11815. https://doi.org/10.1038/s41598-022-15889-x

Rachmawan, D., Seda, F. S. S. E., & Siburian, R. (2022). The Social Forestry in Forest Farmer Group Gunung Gajah Lestari, Pemalang, Indonesia: Encouragement Hope beyond the Limited Choice. In *RUSET 2021: Proceedings of the 2nd International Conference on Rural Socio-Economic Transformation: Agrarian, Ecology, Communication and Community Development Perspectives, RUSET 2021, 14-15 September 2021, Bogor, West Java, Indonesia*, 140. Retrieved from https://eudl.eu/doi/10.4108/eai.14-9-2021.2317169

Sari, W. P., Akmam, & Hidayati. (2018). Analisis struktur batuan berdasarkan data geolistrik tahanan jenis konfigurasi schlumberger dan konfigurasi dipole-dipole di Kecamatan Malalak Kabupaten Agam (Analysis of rock structures based on geoelectric resistance of schlumberger configuration and di. *PILLAR OF PHYSICS*, *11*(2). https://doi.org/10.24036/4641171074

Suharta, R., Tristanti, T., & Hermawan, Y. (2023). Geosphere Profile of Tritis Cave in Gunung Kidul Yogyakarta as a Tourism Object. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 2732–2736. https://doi.org/10.29303/jppipa.v9i5.3327

Sultoni, M. I., Hidayat, B., & Slamet Subandrio, A. (2019). Klasifikasi Jenis Batuan Beku Melalui Citra Berwarna Dengan Menggunakan Metode Local Binary Pattern Dan K-Nearest Neighbor. *TEKTRIKA - Jurnal Penelitian Dan Pengembangan Telekomunikasi, Kendali, Komputer, Elektrik, Dan Elektronika*, *4*(1), 10. https://doi.org/10.25124/tektrika.v4i1.1617

Syah, M. A., Rosana, M. F., & Hardiyono, A. (2020). Karakteristik Petrologi dan Geokimia Batuan Piroklastik Daerah Serawet Provinsi Sulawesi Utara. *Bulletin of Scientific Contribution: GEOLOGY*, *18*(2), 139–150. https://doi.org/10.24198/bsc%20geology.v18i2.28942

Syam, M. (2020). *Studi Karakterisasi Mineral Batuan Beku Parangloe*. Universitas Hasanudin. http://repository.unhas.ac.id/id/eprint/1991/

Syamsiyah, J., & Dewi, W. S. (2014). Dampak Erupsi Gunung Merapi Terhadap Lahan Dan Upaya-Upaya Pemulihannya. *Jurnal Ilmu Ilmu Pertanian*, *XXIX*(1), 61-72. Retrieved from https://jurnal.uns.ac.id/carakatani/article/download/13320/11196