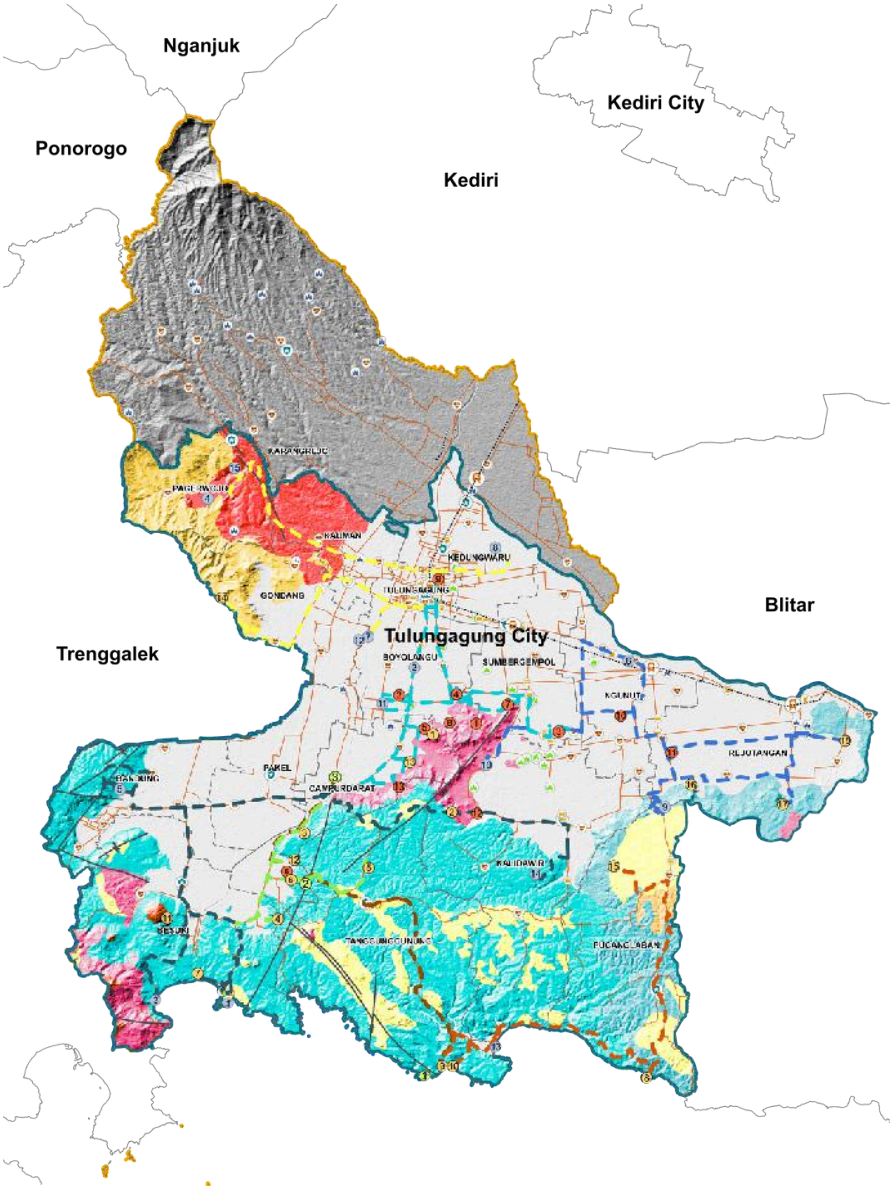
GEOPARK
TULUNGAGUNG

Surga bumi yang menyimpan pesona
batuan purba dan panorama memukau.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BESUKI
PUCANGLABAN

GEOPARK
TULUNGAGUNG
The Home of Wajak Man

Kabupaten Tulungagung memiliki potensi geomorfologi karst yang luar biasa. Utamanya di kawasan selatan Tulungagung yang merupakan kawasan karst dan banyak dijumpai gunung - gunung marmer. Disamping itu, di kawasan ini juga banyak dijumpai fosil - fosil purba, yang berupa hewan, tumbuhan dan bahkan manusia. Kawasan ini layak ditetapkan sebagai geopark dengan keunikan geologi yang dimiliki.

Tulungagung Regency has an extraordinary karst geomorphological potential, especially in the southern region, which is characterized by karst landscapes and numerous marble mountains. In addition, this area is rich in ancient fossils, including those of animals, plants, and even humans. With its unique geological features, this region deserves to be designated as a geopark.

LAPISAN BERFOSIL

PANTAI SANGGAR & PANTAI NGALUR

Lokasi: Kecamatan Tanggunggunung

- **Jenis Warisan Geologi: Stratigrafi laut dangkal berumur Miosen Tengah – Atas**
- **Nilai Unggulan: Fosil laut purba**

Location: Tanggunggunung Subdistrict

- ***Type of Geological Heritage: Shallow marine stratigraphy from the Middle to Late Miocene***
- ***Outstanding Value: Ancient marine fossils***

Tebing-tebing di Pantai Sanggar dan Pantai Ngalur menyimpan kisah purba samudra tropis yang pernah menutupi wilayah Tulungagung sekitar 11 juta tahun lalu. Di dinding batu kapur yang terpapar, kita dapat menemukan fosil-fosil laut seperti moluska, gastropoda, dan kadang-kadang koral. Fosil ini tertanam dalam lapisan batuan sedimen yang terbentuk dari endapan lumpur laut. Situs ini menjadi saksi nyata perubahan bentang alam dari dasar laut menjadi daratan akibat pengangkatan tektonik yang lambat namun pasti.

The cliffs at Sanggar Beach and Ngalur Beach hold ancient stories of a tropical ocean that once covered the Tulungagung area around 11 million years ago. On the exposed limestone walls, we can find marine fossils such as mollusks, gastropods, and occasionally corals. These fossils are embedded in sedimentary rock layers formed from marine mud deposits. This site stands as living evidence of the landscape's transformation from the seafloor into land due to slow but steady tectonic uplift.

Pantai teluk berpasir putih dengan singkapan tebing batuan sedimen yang memperlihatkan kontak Formasi Arjosari (Oligosen Akhir–Miosen Awal) dengan Formasi Campurdarat (Miosen Awal). Lapisan gamping kaya fosil (miliolid, foraminifera besar & kecil), terumbu, serta sisipan batupasir sungai menjadikan lokasi ini laboratorium alami perubahan lingkungan laut dalam ke laut dangkal sampai pengaruh darat.

Kerangka Geologi & Stratigrafi

- **Formasi Arjosari (bawah): Batupasir arkose kaya feldspar; lingkungan lebih dekat darat / laut relatif lebih dalam yang menerima pasokan klastik.**
- **Formasi Campurdarat (atas, Miosen Awal): Beragam litologi batugamping—gamping abu-abu kehitaman, bioklas melimpah, gamping terumbu, dan lapisan yang nyaris seluruhnya tersusun fosil foraminifera bentonik miliolid; disisipi endapan sungai batupasir non-karbonatan berstruktur silang-siur.**

A bay beach with white sand and outcrops of sedimentary rock cliffs displays the contact between the Arjosari Formation (Late Oligocene–Early Miocene) and the Campurdarat Formation (Early Miocene). The limestone layers are rich in fossils (miliolids, large and small foraminifera), reefs, and interbedded fluvial sandstones, making this site a natural laboratory for studying environmental changes from deep marine to shallow marine and even terrestrial influences.

Geological & Stratigraphic Framework

- *Arjosari Formation (lower): Arkosic sandstone rich in feldspar; deposited in a relatively deeper marine environment closer to land, receiving clastic material input.*
- *Campurdarat Formation (upper, Early Miocene): Various limestone lithologies—gray to dark-gray limestones, abundant bioclasts, reef limestones, and layers composed almost entirely of benthic foraminifera (miliolids); interbedded with cross-bedded, non-carbonate fluvial sandstone deposits.*

Fosil Kunci untuk Penentuan Umur & Lingkungan

- **Foraminifera planktonik: Globorotalia fohsi peripheroronda, Globorotalia continuosa (indikator umur).**
- **Foraminifera bentonik kecil: Rotalia becarii, Nonion commune, Elphidium discoidale, E. macellum, Tubinella finalis.**
- **Foraminifera bentonik besar: Miogypsina, Lepidocyclina, Cycloclypeus, Katacycloclypeus, Amphistegina, Alveolinella, Pseudorotalia.**
- **Juga ditemukan kepiting, fosil jejak, terumbu karang; di area Ngalur disebutkan kehadiran foraminifera Slumbergerella dan beragam koral.**

Key Fossils for Age & Environmental Determination

- ***Planktonic foraminifera: Globorotalia fohsi peripheroronda, Globorotalia continuosa (age indicators).***
- ***Small benthic foraminifera: Rotalia becarii, Nonion commune, Elphidium discoidale, Elphidium macellum, Tubinella finalis.***
- ***Large benthic foraminifera: Miogypsina, Lepidocyclina, Cycloclypeus, Katacycloclypeus, Amphistegina, Alveolinella, Pseudorotalia.***
- ***Crabs, trace fossils, and coral reefs were also found; in the Ngalur area, the presence of Slumbergerella foraminifera and various corals was noted.***

Tahapan Pembentukan

1. **Pengendapan Sedimen Klastik Formasi Arjosari di lingkungan laut berenergi variabel dengan suplai material feldspatik dari daratan vulkanik Jawa bagian utara/kerangka busur magmatik awal.**
2. **Transgresi & Perubahan Lingkungan awal Miosen: kondisi laut dangkal hangat memungkinkan berkembangnya karbonat—terbentuk Formasi Campurdarat karbonatan kaya biota.**
3. **Pertumbuhan Terumbu & Produksi Karbonat Tinggi → lapisan bioklas & terumbu; fase energi relatif rendah–menengah intermittent oleh badai/arus menghasilkan struktur laminasi & silang-siur lokal.**
4. **Interupsi Daratan / Saluran Sungai menyisipkan batupasir non-karbonatan ke dalam tatanan karbonat (indikasi fluktuasi muka laut / tektonik lokal / siklus siklostratigrafi).**
5. **Pengangkatan Tektonik Jawa (Oligosen–Miosen) berlanjut sehingga paket karbonat terangkat, tererosi, membentuk tebing pantai kini terekspos; abrasi gelombang menyingkap kontak formasi. Interpretasi tektonik regional didukung juga oleh bukti ketidakselarasan serupa di Winong.**

Formation Stages

1. ***The deposition of clastic sediments of the Arjosari Formation occurred in a marine environment with variable energy, receiving feldspathic material supply from the volcanic hinterland of northern Java / an early magmatic arc framework.***
2. ***During the Early Miocene transgression and environmental changes, warm shallow marine conditions enabled the development of carbonates—forming the biota-rich Campurdarat carbonate Formation.***
3. ***Reef growth and high carbonate production resulted in bioclastic layers and reef structures; phases of relatively low–moderate energy, intermittently influenced by storms/currents, produced laminated and cross-bedded local structures.***
4. ***Terrestrial interruptions and fluvial channels introduced non-carbonate sandstones into the carbonate system (indicating sea-level fluctuations / local tectonics / cyclostratigraphic cycles).***
5. ***Continued tectonic uplift of Java (Oligocene–Miocene) caused the carbonate packages to be elevated and eroded, forming coastal cliffs now exposed; wave abrasion has revealed the formation contacts. Regional tectonic interpretation is also supported by similar unconformity evidence in Winong.***

PANTAI SANGGAR

PANTAI NGALUR

Nilai Penting

Ilmiah: Rekaman transisi lingkungan & penunjuk umur Formasi Campurdarat; keragaman biota fosil luar biasa.

Significance

Scientific: A record of environmental transitions and age indicators of the Campurdarat Formation; exceptional diversity of fossil biota.

GOA BERFOSIL

TENGGAR

Lokasi: Kecamatan Tanggunggunung

- **Jenis Warisan Geologi: Karst dengan fosil di dalam batuan**
- **Nilai Unggulan: Goa dengan sisa kehidupan laut purba**

Location: Tanggunggunung District

- ***Type of Geological Heritage: Karst with fossils within the rocks***
- ***Outstanding Value: Cave containing remnants of ancient marine life***

Goa Tenggar adalah sebuah lorong karst alami yang terbentuk dari proses pelarutan batu gamping. Menariknya, pada dinding-dinding dalam goa masih tampak fosil laut purba seperti foraminifera dan fragmen koral. Artinya, batuan ini dulunya terbentuk di bawah laut dangkal sebelum diangkat ke daratan dan dilubangi oleh air hujan asam. Ini adalah tempat langka di mana pengunjung bisa melihat hubungan langsung antara proses geologi dan sisa kehidupan masa lalu. Goa karst aktif dengan aliran sungai bawah tanah, stalaktit–stalagmit yang masih tumbuh, dan temuan fosil megafauna (gajah, kura-kura, rusa, banteng, kerbau) terperangkap dalam endapan goa.

Tenggar Cave is a natural karst passage formed through the dissolution of limestone. Interestingly, the inner walls of the cave still display ancient marine fossils such as foraminifera and coral fragments. This indicates that the rocks were originally formed in a shallow marine environment before being uplifted onto land and carved out by acidic rainwater. It is a rare site where visitors can directly observe the connection between geological processes and remnants of past life. The cave is an active karst system with an underground river, still-growing stalactites and stalagmites, and discoveries of megafauna fossils (elephant, turtle, deer, banteng, and buffalo) trapped within the cave deposits.

Proses Pembentukan

1. **Pelarutan Batugamping (karstifikasi) sepanjang rekahan & zona lemah pada perbukitan karbonat selatan Tulungagung membentuk rongga awal.**
2. **Pengembangan Uvala di Atas Goa menyediakan suplai air berlimpah; perkolasi kaya karbonat menumbuhkan speleothem (stalaktit, stalagmit; lokal disebut watu jarit).**
3. **Sungai Bawah Tanah Aktif menggerus lantai goa, mengangkut sedimen dan sisa organisme; saat banjir musiman, ruang goa menjadi perangkap alami fragmen tulang & fosil fauna besar.**
4. **Akumulasi Endapan Goa & Diagenesis Lokal mengawetkan fosil dalam matriks lempung/kalcit sekunder di dinding & lantai goa.**

Formation Process

1. ***Limestone Dissolution (karstification): Dissolution of limestone along fractures and weak zones in the southern Tulungagung carbonate hills created the initial cavities.***
2. ***Uvala Development Above the Cave: The formation of uvalas above the cave provided abundant water supply; carbonate-rich percolation fostered the growth of speleothems (stalactites and stalagmites, locally known as watu jarit).***
3. ***Active Underground River: The underground river scoured the cave floor, transporting sediments and organic remains; during seasonal floods, the cave chambers became natural traps for bone fragments and large fauna fossils.***
4. ***Cave Sediment Accumulation and Local Diagenesis: Fossils were preserved within clay or secondary calcite matrices on the cave walls and floor.***

GOA TENGGAR

Nilai Penting

- **Ilmiah: Arsip paleofauna vertebrata subkuarter, dinamika sistem air karst aktif.**
- **Edukasi: Contoh proses speleogenesis & konservasi fosil gua.**
- **Geowisata: Trek petualangan (akses jalan dilanjut jalan kaki melewati lahan pertanian & perbukitan).**

Significance

- ***Scientific: Archive of Sub-Quaternary vertebrate paleofauna and the dynamics of an active karst water system.***
- ***Educational: An example of speleogenesis processes and cave fossil conservation.***
- ***Geotourism: Adventure trekking (access via road followed by a hike through farmland and hills).***

KOMPLEK GOA

GEOARKEOLOGI WAJAK

Lokasi: Kecamatan Campurdarat

- **Jenis Warisan Geologi & Budaya: Karst, situs manusia purba**
- **Nilai Unggulan: Fosil manusia purba Homo wajakensis**

Location: Campurdarat District

- ***Type of Geological & Cultural Heritage: Karst, early human site***
- ***Outstanding Value: Fossil of early human Homo wajakensis***

Goa Wajak bukan sekadar rongga alam, tetapi saksi penting sejarah manusia di Indonesia. Di sini pada akhir abad ke-19 ditemukan fosil manusia purba Homo wajakensis, yang diperkirakan hidup 40.000–20.000 tahun lalu. Goa-goa ini terbentuk dari pelarutan batu gamping oleh air hujan dan sungai bawah tanah, menciptakan lorong-lorong yang digunakan manusia purba sebagai tempat tinggal. Kawasan karst Formasi Campurdarat ini terkenal karena temuan fosil Homo wajakensis (Wajak 1 & 2; ditemukan oleh Van Rietschoten pada 1888 dan diteliti lebih lanjut oleh Eugene Dubois tahun 1890–1891), serta fosil fauna laut dan darat. Kawasan ini menyimpan jejak penting kehidupan awal manusia modern di Jawa dan lingkungan karbonat Miosen yang kemudian dimanfaatkan sebagai hunian prasejarah.

The Wajak Cave is an important witness to the history of humans in Indonesia. In the late 19th century, fossils of the ancient human Homo wajakensis, estimated to have lived 40,000–20,000 years ago, were discovered here. These caves were formed by the dissolution of limestone by rainwater and underground rivers, creating passages that were used by prehistoric humans as dwellings. The karst area of the Campurdarat Formation is famous for the discovery of Homo wajakensis fossils (Wajak 1 & 2; first found by Van Rietschoten in 1888 and later studied by Eugene Dubois in 1890–1891), as well as marine and terrestrial animal fossils. This area preserves important traces of early modern human life in Java and the Miocene carbonate environment that was later used as prehistoric habitation.

- **Terletak pada perbukitan batugamping Miosen (Formasi Campurdarat) yang mengalami pelarutan intensif sehingga terbentuk banyak gua: Wajak Site, Hoekgrot Site, Kecil (Suli) Site, dsb.**
- **Karstifikasi dikontrol struktur kekar & sesar yang memfasilitasi pembentukan rongga-rongga dihuni manusia purba.**

- **Located in the Miocene limestone hills (Campurdarat Formation), which have undergone intensive dissolution, resulting in the formation of numerous caves: Wajak Site, Hoekgrot Site, Kecil (Suli) Site, and others.**
- **Karstification is controlled by joint and fault structures that facilitated the formation of cavities later inhabited by prehistoric humans.**

Kronologi Penemuan & Penelitian Singkat

1. **28 Okt 1888 – Van Rietschoten menemukan fragmen tengkorak (Wajak 1).**
2. **Sep–Okt 1890 – Eugene Dubois lakukan ekskavasi; temukan rahang atas/bawah (Wajak 2).**
3. **Des 1890–Jan 1891 – Eskavasi lanjutan (Hoekgrot, Kecil Site) temukan fragmen tulang manusia & fauna.**
4. **Situs diakui sebagai rujukan penting paleoantropologi Asia Tenggara; replika fosil kini berada di Tulungagung.**

Chronology of Discovery & Brief Research

1. ***28 Oct 1888 – Van Rietschoten discovered a skull fragment (Wajak 1).***
2. ***Sep–Oct 1890 – Eugene Dubois conducted excavations; discovered upper and lower jawbones (Wajak 2).***
3. ***Dec 1890–Jan 1891 – Further excavations (Hoekgrot, Kecil Site) uncovered human bone fragments and fauna remains.***
4. ***The site is recognized as an important reference for Southeast Asian paleoanthropology; fossil replicas are now housed in Tulungagung.***

Tahapan Pembentukan Geologi-Arkeologi Terintegrasi

1. **Pengendapan karbonat Miosen & pembentukan batugamping Campurdarat.**
2. **Tektonik & Pelarutan Karst membuka rongga gua multi-ruang.**
3. **Akumulasi Sedimen Goa + Aktivitas Biotik (kelelawar, aliran air) menciptakan lingkungan pengawetan fosil.**
4. **Kehadiran Manusia Purba (Late Pleistosen menurut literatur paleoantropologi) – membuat hunian episodik meninggalkan artefak & sisa rangka.**
5. **Nilai Penting**

- **Ilmiah: Rekaman paleoantropologi kelas dunia ditamba konteks karst Miosen.**
- **Edukasi: Situs kunci pengajaran evolusi manusia di Indonesia**

Stages of Integrated Geological-Archaeological Formation

1. ***Miocene carbonate deposition & formation of Campurdarat limestone.***
2. ***Tectonics and karst dissolution opened multi-chamber cave voids.***
3. ***Cave sediment accumulation + biotic activity (bats, water flow) created a fossil preservation environment.***
4. ***Presence of prehistoric humans (Late Pleistocene, according to paleoanthropological literature) – episodic habitation leaving behind artifacts and skeletal remains.***
5. ***Significance***

- ***Scientific: World-class paleoanthropological record complemented by Miocene karst context.***
- ***Educational: A key site for teaching human evolution in Indonesia.***

GEOARKEOLOGI WAJAK

GUNUNG API PURBA

BUDEG

Lokasi: Kecamatan Campurdarat

- **Jenis Warisan Geologi: Gunung api bawah laut berumur Oligosen – Miosen**
- **Nilai Unggulan: Struktur vulkanik purba**

Location: Campurdarat District

- ***Type of Geological Heritage: Submarine volcano from the Oligocene–Miocene age***
- ***Outstanding Value: Ancient volcanic structures***

Gunung Budeg yang kini tampak tenang dulunya adalah gunung api bawah laut aktif sekitar 25 juta tahun lalu. Batuan andesit dan breksi vulkanik menjadi bukti erupsi yang telah lama padam. Seiring waktu, gunung ini terangkat ke permukaan dan mengalami pelapukan, hingga kini muncul sebagai bukit terisolasi di tengah dataran. Litologinya didominasi breksi piroklastik, lava andesit, dan intrusi andesit. Survei geofisika juga menunjukkan adanya struktur miring yang kemungkinan sisa tepi kawah gunung api purba berumur 20–30 juta tahun.

Mount Budeg, which now appears calm, was once an active submarine volcano around 25 million years ago. Andesite rocks and volcanic breccia serve as evidence of long-extinct eruptions. Over time, the volcano was uplifted to the surface and underwent weathering, eventually forming an isolated hill in the middle of the plain. Its lithology is dominated by pyroclastic breccia, andesite lava, and andesite intrusions. Geophysical surveys also indicate the presence of an inclined structure, possibly the remnant of the ancient volcanic crater rim dated to approximately 20–30 million years ago.

- **Kerangka Vulkanostratigrafi**

Produk erupsi piroklastik tersingkap sebagai breksi & aglomerat; lava andesit menandai aliran kental; intrusi andesit menerobos tubuh gunung dan kini terekspos erosi diferensial.

- **Bukti Geofisika & Interpretasi Kawah Purba**

Pemindaian gradiomagnetik & GPR oleh Pusat Survei Geologi (dilaporkan 23 Maret 2022) mendeteksi anomali benda padat masif (andesit) berbentuk lorong menyerong ke tenggara–barat, diinterpretasikan sebagai batuan terobosan dari pinggiran kawah dalam kompleks gunung api berdiameter ±2,7 km yang kini tererosikan (kaldera sisa).

- **Volcanostratigraphic Framework**

Pyroclastic eruption products are exposed as breccia and agglomerate; andesite lava marks viscous flows; andesite intrusions penetrated the volcanic body and are now exposed due to differential erosion.

- **Geophysical Evidence & Ancient Crater Interpretation**

Gradiomagnetic and GPR surveys conducted by the Geological Survey Center (reported on March 23, 2022) detected anomalies of massive solid bodies (andesite) in a southeast–west inclined corridor, interpreted as intrusive rocks from the crater rim within a volcanic complex approximately 2.7 km in diameter, now eroded into a residual caldera.

Tahapan Evolusi

1. **Aktivitas Vulkanik Andesitik (Miosen Awal atau sekitar 20–30 juta tahun lalu) membentuk endapan piroklastik–lava.**
2. **Intrusi Lanjut & Pendinginan membentuk tubuh andesit masif di kedalaman dangkal.**
3. **Erosi Panjang Waktu mengikis kerucut, meninggalkan sumbat/intrusi resisten sebagai bukit Budeg yang kita lihat kini.**
4. **Pelapukan Tropis & Penggunaan Lahan menciptakan lereng vegetasi campuran; singkapan terbaik di area bukit & pemotongan jalan.**

Evolutionary Stages

1. ***Andesitic Volcanic Activity (Early Miocene, around 20–30 million years ago) formed pyroclastic and lava deposits.***
2. ***Subsequent Intrusion & Cooling created a massive andesite body at shallow depths.***
3. ***Prolonged Erosion stripped away the volcanic cone, leaving behind resistant plugs/intrusions that now form Mount Budeg.***
4. ***Tropical Weathering & Land Use shaped mixed-vegetation slopes; the best outcrops are found around the hill and road cuts.***

GUNUNG API PURBA BUDEG

Nilai Penting

- **Contoh edukatif evolusi gunung api tropis yang tereksumhasi; peluang komparasi dengan Gunung Api Purba Nglanggeran di DIY untuk materi perbandingan buku saku.**

Significance

- ***An educational example of an exhumed tropical volcano; offers a comparison opportunity with the ancient Nglanggeran Volcano in Yogyakarta for pocketbook reference material.***

TERAS PANTAI

KEDUNG TUMPANG

Lokasi: Kecamatan Pucanglaban

- **Jenis Warisan Geologi: Teras marin hasil pengangkatan tektonik**
- **Nilai Unggulan: Teras batuan sedimen pantai aktif**

Location: Pucanglaban District

- ***Type of Geological Heritage: Marine terraces formed by tectonic uplift***
- ***Outstanding Value: Active coastal sedimentary rock terraces***

Teras Kedung Tumpang menampilkan lapisan-lapisan batu sedimen pantai yang terbentuk akibat hempasan ombak jutaan tahun lalu. Teras ini merupakan bukti nyata dari pengangkatan daratan secara perlahan akibat aktivitas tektonik di zona subduksi Selatan Jawa. Formasi teras-tebing ini kini memikat wisatawan karena kolam-kolam alami di antaranya, namun lebih dari itu, ia menyimpan catatan geologi panjang perubahan garis pantai Jawa. Pantai batugamping memanjang yang menampilkan teras pantai bertingkat dengan lubang-lubang bundar (pothole) terisi bongkah bulat; fasies karbonat Formasi Wonosari (Miosen Tengah) kaya foraminifera bentonik besar (Flosculinela, Miogypsina, Amphistegina, Operculina, dll.) plus koral & moluska. Situs unggulan untuk mempelajari interaksi energi gelombang, abrasi, dan rekaman paleo-lingkungan karbonat.

The Kedung Tumpang terraces showcase layers of coastal sedimentary rocks formed by wave action millions of years ago. These terraces are clear evidence of the gradual uplift of land due to tectonic activity along the Java Southern subduction zone. This terrace-cliff formation now attracts tourists with its natural pools, but beyond its beauty, it holds a long geological record of shoreline changes in Java. The elongated limestone coast features stepped marine terraces with rounded holes (potholes) filled with spherical boulders. The carbonate facies of the Wonosari Formation (Middle Miocene) are rich in large benthic foraminifera (Flosculinella, Miogypsina, Amphistegina, Operculina, etc.), as well as corals and mollusks. This is a key site for studying wave energy interaction, abrasion processes, and carbonate paleoenvironmental records.

Kerangka Litostratigrafi

- **Perselingan batugamping bioklas, batugamping berbutir, gamping berlumpur berlaminasi, gamping berfragmen pasiran; sisipan tephra & batupasir tufan menunjukkan pengaruh episodik vulkanik ke cekungan karbonat.**

Proses Pembentukan Teras & Pothole

1. **Pengangkatan dan penurunan relatif muka laut menciptakan permukaan abrasi bertingkat (teras).**
2. **Arus turbulen memutar kerakal dalam lubang abrasi kemudian memperbesar pothole dan batu-batu bulat ukuran bola basket sebagai grinder alami.**

Lithostratigraphic Framework

Interbedded bioclastic limestone, grainstone, laminated marlstone, and sandy-fragmental limestone; tephra and tuffaceous sandstone layers indicate episodic volcanic influence on the carbonate basin.

Formation Processes of Terraces & Potholes

1. ***Uplift and relative sea-level changes created stepped abrasion surfaces (marine terraces).***
2. ***Turbulent currents rotated pebbles within abrasion holes, gradually enlarging the potholes and shaping basketball-sized rounded stones as natural grinders.***

TERAS PANTAI KEDUNG TUMPANG

Nilai Penting

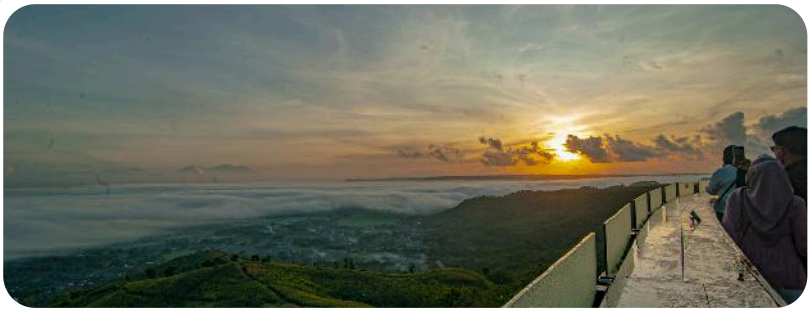
- **Ilmiah: Rekaman awal pembentukan Formasi Wonosari & dinamika muka laut.**
- **Geowisata: Lanskap fotogenik kolam alami—populer saat surut; penting edukasi keselamatan (ombak selatan Jawa).**

Significance

- ***Scientific: Records the early development of the Wonosari Formation and sea-level dynamics.***
- ***Geotourism: A photogenic landscape with natural pools—popular during low tide; also important for safety education (South Java waves).***

KETIDAKSELARASAN

WINONG – PUNCAK JOWIN



Lokasi: Kecamatan Kalidawir

- **Jenis Warisan Geologi: Ketidakselarasan angular (angular unconformity)**
- **Nilai Unggulan: Hubungan antarformasi batuan yang tidak sejajar**

Location: Kalidawir District

- ***Type of Geological Heritage: Angular unconformity***
- ***Outstanding Value: The relationship between rock formations with non-parallel layering***

Di Puncak Jowin, pengunjung bisa melihat contoh klasik ketidakselarasan angular—yaitu pertemuan antara dua kelompok batuan yang berbeda usia dan kemiringan lapisan. Lapisan batuan tua yang miring tertutup oleh lapisan batuan muda yang mendatar. Fenomena ini menunjukkan terjadinya proses geologi berulang: pelipatan, erosi, lalu pengendapan ulang. Situs ini merupakan buku terbuka sejarah bumi yang menggambarkan tektonisme di masa lalu. Bukit setinggi ±30 m di rangkaian perbukitan Puncak Jowin mengekspos kontak stratigrafi tak selaras (unconformity) antara Formasi Arjosari (Oligosen; breksi sedimen monomik) dan Formasi Campurdarat (Miosen Awal; batugamping pasiran). Situs kunci untuk menjelaskan pengangkatan Pulau Jawa Oligosen–Miosen dan perubahan lingkungan laut dalam hingga laut dangkal.

At Puncak Jowin, visitors can observe a classic example of an angular unconformity the meeting point of two rock groups of different ages and layer orientations. Older tilted rock layers are overlain by younger, nearly horizontal layers. This phenomenon illustrates a repeated geological process: folding, erosion, and subsequent redeposition. The site is an open book of Earth's history, revealing past tectonic activity. A hill approximately 30 meters high in the Puncak Jowin ridge exposes an unconformable stratigraphic contact between the Arjosari Formation (Oligocene; monomict sedimentary breccia) and the Campurdarat Formation (Early Miocene; sandy limestone). This is a key site for explaining the Oligocene–Miocene uplift of Java and the environmental shift from deep marine to shallow marine settings. Would you like me to also prepare a shorter, more engaging version (for a geopark sign or visitor guide)?

Mengapa "Ketidakselarasan" Penting?

Unconformity menandai jeda waktu geologi: erosi yang memotong unit lebih tua (Arjosari) sebelum ditutupi sedimen lebih muda (Campurdarat).

Tahapan Pembentukan

1. **Pengendapan breksi sedimen Arjosari di lingkungan laut lebih dalam/lereng dengan suplai klastik.**
2. **Pengangkatan &/atau penurunan muka laut menyebabkan erosi permukaan atas Arjosari.**
3. **Transgresi laut dangkal karbonat menutup permukaan erosi → endapan gamping pasiran Campurdarat kaya fosil moluska & jejak biologi.**
4. **Pengangkatan lanjut membentuk bukit Winong; sekarang terekspos untuk pengamatan.**

Apa yang Diamati di Lapangan

- **Permukaan kontak erosional (identifikasi perubahan butir & warna).**
- **Fragmen breksi monomik di bawah; gamping pasiran di atas.**
- **Cetakan cangkang moluska & fosil jejak dalam gamping.**
- **Panorama dataran Tulungagung dari Puncak Jowin (titik interpretasi regional).**

Why is an "Unconformity" Important?

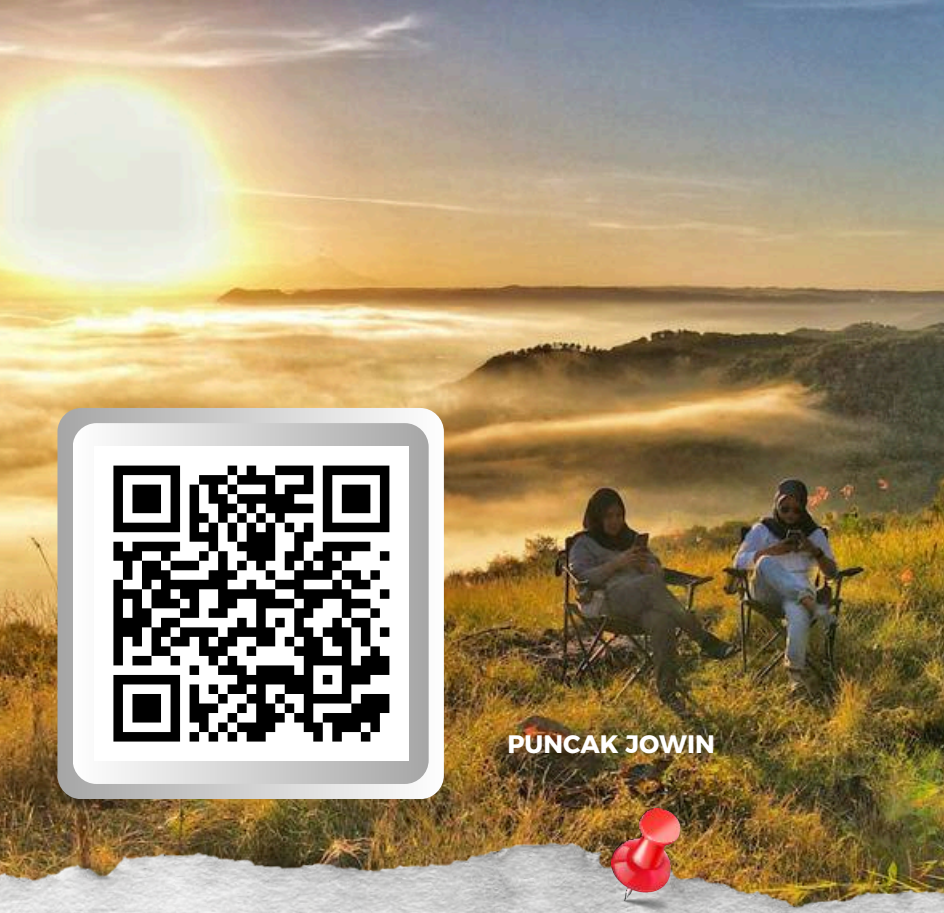
An unconformity marks a gap in geological time: erosion that cut through older units (Arjosari Formation) before being overlain by younger sediments (Campurdarat Formation).

Formation Stages

- ***Deposition of sedimentary breccia (Arjosari) in a deeper marine/slope environment with clastic input.***
- ***Uplift and/or sea-level fall caused erosion of the upper surface of Arjosari.***
- ***Shallow marine carbonate transgression covered the erosional surface → deposition of sandy limestone (Campurdarat) rich in mollusk fossils and trace fossils.***
- ***Further uplift formed Winong Hill, which is now exposed for observation.***

What to Observe in the Field

- ***The erosional contact surface (identified by changes in grain size and color).***
- ***Monomict breccia fragments below; sandy limestone above.***
- ***Mollusk shell imprints and trace fossils within the limestone.***
- ***Panoramic view of the Tulungagung plain from Puncak Jowin (a key regional interpretation point).***



PUNCAK JOWIN

Nilai Penting

- **Ilmiah: Bukti lapangan langsung proses pengangkatan Jawa kala Oligosen–Miosen.**
- **Edukasi: Lokasi ideal mengajarkan konsep ketidakselarasan**
- **Geowisata: Area puncak populer untuk sunrise & camping**

Significance

- ***Scientific: Direct field evidence of Java's uplift during the Oligocene–Miocene.***
- ***Educational: An ideal location to teach the concept of unconformities.***
- ***Geotourism: A popular summit area for sunrise viewing and camping.***

TELAGA
BURET

Lokasi: Kecamatan Campurdarat

- **Jenis Warisan Geologi: Danau endokarst di cekungan batu gamping**
- **Nilai Unggulan: Sistem air bawah tanah karst**

Location: Campurdarat District

- ***Type of Geological Heritage: Endokarst lake in a limestone basin***
- ***Outstanding Value: Karst underground water system***

Telaga permanen ±30 × 40 m yang tidak pernah kering karena berfungsi sebagai outlet sistem air bawah tanah karst perbukitan gamping sekitarnya; dibatasi tebing patahan utara–selatan di belakang telaga. Interaksi hidrologi-karst-ekologi menjadikannya geosite unggulan air di Tulungagung selatan. Telaga Buret adalah danau kecil alami yang terbentuk di kawasan karst Campurdarat. Airnya berasal dari sistem sungai bawah tanah yang muncul di permukaan melalui mata air. Fenomena ini disebut endapan air pada dolina tertutup. Telaga ini tidak memiliki sungai keluar—airnya mengalir kembali ke bawah tanah melalui rekahan dan saluran karst. Kawasan ini penting bagi konservasi air dan biodiversitas.

A permanent lake measuring approximately 30 × 40 m that never dries up, functioning as the outlet of the underground karst water system from the surrounding limestone hills. It is bordered by a north–south fault scarp behind the lake. The interaction of hydrology, karst, and ecology makes it a flagship water geosite in southern Tulungagung.

Telaga Buret is a small natural lake formed in the karst area of Campurdarat. Its water comes from an underground river system that emerges at the surface through a spring. This phenomenon is known as water accumulation in a closed doline. The lake has no surface outflow—the water drains back underground through fractures and karst conduits. The area is important for water conservation and biodiversity.

Proses Hidrogeologi

1. **Infiltrasi air hujan ke retakan batugamping karst; air mengalir melalui jaringan rekahan & lorong terlarut menuju zona rendahan.**
2. **Konsentrasi aliran pada jalur patahan & zona permeabilitas lebih tinggi → muncul sebagai mata air/telaga di depresi Buret.**
3. **Pengisian stabil sepanjang tahun mencerminkan reservoir karst terhubung luas; fluktuasi muka air relatif kecil dibanding telaga dangkal biasa.**

Apa yang Diamati di Lapangan

- **Dimensi telaga (ukur panjang-lebar).**
- **Kelimpahan vegetasi riparian & satwa air (indikator air permanen).**
- **Sumber masuk/keluar air (aliran rembesan, overflow musiman).**

Hydrogeological Processes

1. ***Rainwater infiltrates through fractures in the karst limestone; water flows along a network of cracks and dissolved conduits toward low-lying zones.***
2. ***Concentrated flow along fault lines and zones of higher permeability emerges as springs/lakes in the Buret depression.***
3. ***Stable year-round recharge reflects a widely connected karst reservoir; water level fluctuations are relatively small compared to typical shallow lakes.***

What to Observe in the Field

- ***Lake dimensions (measure length and width).***
- ***Abundance of riparian vegetation and aquatic fauna (indicators of a permanent water body).***
- ***Water inlets/outlets (seepage flows, seasonal overflow).***

TEALAGA BURET

Nilai Penting

- **Ilmiah: Model mini sistem akuifer karst terbuka; bagus untuk menjelaskan neraca air di daerah gamping.**
- **Ekologi & Konservasi: Suplai air permanen mendukung keanekaragaman hayati & komunitas lokal; potensi wisata alam rendah jejak karbon.**

Significance

- ***Scientific: A miniature model of an open karst aquifer system; ideal for explaining water balance in limestone areas.***
- ***Ecology & Conservation: The permanent water supply supports biodiversity and local communities; potential for low-carbon nature-based tourism.***

GEOPARK TULUNGAGUNG
The Home of Wajak Man

DAFTAR PUSTAKA

Badan Geologi. (2022). Laporan Survei Geofisika Gunung Budeg. Bandung: Pusat Survei Geologi.

Dubois, E. (1894). Homo Wajakensis: Penemuan Manusia Purba di Jawa. Leiden: E.J. Brill.

Rietschoten, van. (1888). Catatan Ekskavasi Fosil Homo Wajakensis. Batavia: Drukkerij Lands.

Surono, & Gafoer, S. (1992). Peta Geologi Lembar Tulungagung. Bandung: Pusat Penelitian dan Pengembangan Geologi.

Widodo, S., & Santoso, B. (2015). Warisan Geologi Tulungagung: Dari Karst ke Vulkanik Purba. Yogyakarta: UGM Press.

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NOTE

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