The Siulak fault segment an important role in the presence of geo-diversity in Sungai Penuh for the proposed geo-tourism site

Hari Wiki Utama [1*], Heriberta[2], Emilia[2], and *Ade* Adriadi[3]

[1]Geological Engineering, Universitas Jambi, 36361 Muaro Jambi, Jambi, Indonesia
[2]Economic Development, Universitas Jambi, 36361 Muaro Jambi, Jambi, Indonesia
[3]Biology, Universitas Jambi, 36361 Muaro Jambi, Jambi, Indonesia

Abstract. Sungai Penuh is one of the municipality or regency in the Jambi Province, Indonesia which is traversed by the Siulak Fault segment. The fault zone has geodiversity and the related of biodiversity. Therefore, this site could be proposed as one of the geo-tourism site which of course its use based on sustainable development. The aim of the study is to provide up to date information the presence of geodiversity, such as geothermal features manifestation, geological landscape, and the mass movement as geological hazard. In the Sungai Penuh has geodiversity to proposed geo-tourism that four site, which is Sungai Medang Hot Spring, Semurup Hot Spring, Kerinci Lake landscape, Panorama Peak. Sungai Penuh Basin landscape, and Tanco isolated hill are related to the four geo-tourism. The geodiversity provides a demand for tourism-loving communities to preserve geological heritage in the concept of geological conservation to be proposed as a geo-tourism site. So that, this role can be later have a positive impact on the community around geo-tourism objects based on sustainable development. In this effort to conserve geological heritage, of course, geo-tourism objects must have a good impact on geo-tourists, such as making signboards about geo-tourism objects in the form of understanding storytelling.

1 Introduction

Fault potential is a part of geodynamic on earth crust topographic surface the consequence of tectonic activity. There is indication major deformation [1, 2, 3]. This formation would be basin space on the surface which in time is occupied by geological diversity (geodiversity) [2, 4, 5, 6]. Sumatra Island has 19 until 55 active fault segmented, which orientation of northwestern – southeastern and extend from Aceh with Aceh segmented the reach to southern of Lampung, that is Semangko segmented the formation of Semangko gulf [1, 3, 7, 8]. The active fault in the orogenesis of Barisan Range the made of ondulation morphology in Sumatra. Sungai Penuh is one of territory in Jambi Province which has been passed by active Sumatran Fault System of Siulak segmented the linkage of Kerinci Lake and Sungai Penuh Basin (Fig. 1). This active fault movement is a dextral fault system, where eastern segmented the specifically eastern of Kerinci Lake is passive relatively, meanwhile the western part of Kerinci Lake is actively moving to the northwestern [1, 3, 9, 10, 11]. The movement of this active fault is evidenced by path or traces of past earthquakes such as 1995 earthquake [4, 5, 7, 11, 12].

Sungai Penuh is one of area which has various geological phenomenon or known geodiversity as produce of tectonic activity regarding to volcanism [3, 5, 13, 14]. Geodiversity found in this area include Kerinci Mountain which is the highest active volcano in Sumatra “Sumatran roof”, active fault system the associated with Gunung Tujuh Lake, the existence of waterfall, geothermal potential as well as another unique geological phenomenon.

Geological processes that occur along the active fault zone have a significant impact on changes in surface topography in the Sungai Penuh, this is identified from the some of landslide/movement area zones that are on the fault zone. The negative impact has proportional to its positive potential, namely to form a landscape that can used as a tourist attraction. Not a few also in the avalanche zone is occupied by geodiversity, this of course must be carried out an inventory to provide a potential that can be exploited [5, 6, 15, 16]. The study and analysis are certainly very able to provide a positive potential in the zone become a sustainable geotourism that utilizes the beauty of the landscape become a scientific narrative that relates geological and biological manifestations be of economic value.

Geological inventory of geodiversity becomes a major component to find out the type, use, and economic or scientific value of geodiversity variation along the active fault zone. The unique morphology of the zone this provides an indication of the relationship between of fault hills in the along orogenesis zone of the Barisan Range during Quarternary [3, 5, 17, 18, 19, 20].

To understanding the process of The Siulak fault segment plays an important role in the presence of

* Corresponding author: h.wikiutama@unja.ac.id

geodiversity on the Sungai Penuh to proposed Geotourism site. It is necessary to identify surface manifestations on the fault plane movement zone and inventory geodiversity that reflects the variety of geodiversity that grows in along the fault zone. These results can later be used for geotourism sustainable and can also be used as science for natural laboratories. Not only geodiversity is the main manifestation along this fault zone, geological manifestations such as geothermal, landscapes such as Kerinci Lake into a unified geodiversity complex that can be understood and later can be used as sustainable geotourism on the Sungai Penuh. The urgency of this research is to utilize regional areas geological disaster as a geotourism area by considering the main aspects of geodiversity, so that it has the potential as a sustainable geotourism with an emphasis on economic value.

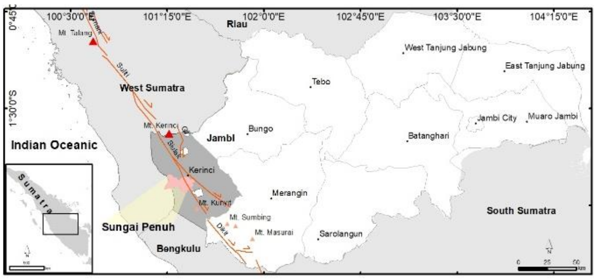

Fig. 1. Location for the research area on the Sungai Penuh (pink polygon). This research detailed along Siulak segmented on major road (red line). Deliniation of Sumatran Fault System based on research by [1, 3, 21, 22]

2 Regional Geology

Sumatra is part of the Sunda Mainland as a result of subduction convergence from the Indian Oceanic plate boundary that subducts against the Eurasian plate during the Paleogene - Quartenary which is thought to have caused the rotation of the Sumatra Island clockwise. the change position of the initial position in the beginning orientation western - eastern to be northwestern - souteastern [3, 23, 24, 25, 26]. The changes in the deformation of Sumatra Island which undergo rotation occurs at Oligocene-Miocene period. This deformation causes the movement of the Sumatran Fault System which began to be active at that time [1, 3, 27, 28, 29].

Stratigraphic consist in the Sungai Penuh is Bandan Formation of pyroclastic and epiclastic product (Peb), Kumun Formation of sedimentary and epiclastic (Nmk), sheared basalt as produce of tectonic deformation (Npb), Sungai Penuh Granodiorite (Npgds), Pengasih Formation of pyroclastic and epiclastic product (QNp), Mountain Kebongsong (Qvkb), Mountain Tarasih (Qvtr), Mountain Talang (Qvtl), and Alluvium (Qa) filling the basin of Sungai Penuh Basin and the western ridge of the Barisan Range which is also in the western part of the basin [1, 3, 22, 30, 31, 32, 33, 35] (Fig. 2).

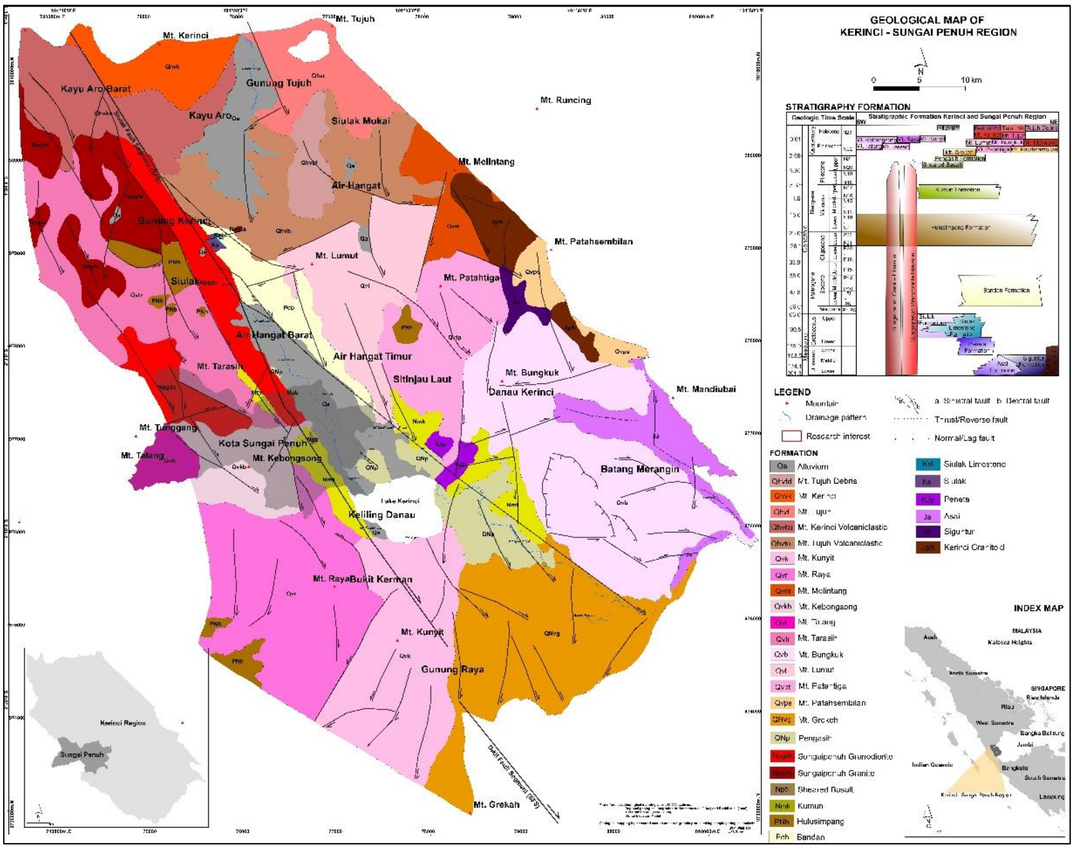

Fig. 2. Geological Map of Kerinci Region - Sungai Penuh (grey polygon) [6, 22, 31, 32, 33]

Sumatra tectonics is influenced by the convergence of the Indian Oceanic Plate and the Eurasian Continental Plate, thus giving an effect on rocks deformation and estimated have caused the rotation of the island of Sumatra in a clockwise direction. This change in the position of the island of Sumatra which was originally trending west - east to northwest - southeast. Deformation change The island of Sumatra which experienced rotation occurred during the Oligo-Miocene. This deformation caused the movement of the Sumatran fault which began to active at that time. The convergence of these plates is thought to have moved 5 - 7 cm/year [1, 7, 9, 34, 36].

The island of Sumatra is composed of suture sutures or continental blocks that form a single continental crust including the Woyla Nappe Block, West Sumatra Block, Sibumasu Block (East Sumatra), Quartzite-Granite Series, Indochina Block [3, 4, 10, 11]. The continental block grouped into several groups based on their tectonic phase, including Tapanuli as bedrock aged Carbon - Permian, Peusangan Group aged Permian - Triassic, and the Woyla Group Jurassic - Cretaceous. Sumatran tectonic conditions are so complex with rock groups and their geological structure, have an impact on the different morphological conditions [9, 12, 13, 15, 21].

3 Data and Method

The method used in this study aims to detail each stage of the research. Literature review from the latest sources related to active faults of Siulak segmented, especially in active Sumatran Faults, then the source of research related to the geodiversity. Detailed digital elevation model of contour topographic, hillshade Digitam Elevation Model (DEM) which scale 1:50.000, geological features data provides reliable basis for interpretation in this research. Interpretation of DEM data will be tied to structural mechanism and dynamic effect of structural deformation the related to geodiversity. Structural mechanism analysis based on interpretation DEM data and evidence structural in the field.

Field work begins with the measurement of the existence of fault indication in the form of measuring fault plane and slickenside. Measuring too including the fracture dimensions. For this dimension would be integrated with analysis geological structure on DEM. Field work was also carried out in the form of an inventory of geodiversity in along the active fault. This geodiversity would be recorded based on type and availability. So, with this data, it would be obtained geodiversity along active fault zones and of course as a factor in realizing the concept of geodiversity.

The integration of field work and analysis would be result in a geological map that is it includes the distribution of the geodiversity reflecting geodiversity along active faults. This data will later further analyzed by analysis for geotourism, namely providing an assessment related to geological manifestations along active faults with geodiversity and of course considering local wisdom to make it happen sustainable development. By considering analysis and to support positive impacts for the community or the region it requires an analysis or economic study, especially from the utilization of geotourism that has fulfilled the geological and biological aspects that can growth economic value for society.

4 Result

Field activities that have been carried out in the Sungai Penuh focus on along the active fault of the Siulak segmented. This research by observing how geological phenomenon formed as a result of this active fault. The geological phenomenon formed would be understood in more detail related to biodiversity. This research also pays attention to geological features manifestation the linkage of active faults such as in the geothermal manifestation area on the Semurup (Fig. 3) and Sungai Medang (Fig. 4). In addition, other objects are in related tourist attractions with plantations. All of these objects must be along and around the fault active Siulak segmented.

Fig. 3. Overview of Semurup Geothermal manifestation. a) hot pool and hot spring with silica sintere on the wedge of manifestations, b) silica sintere which stratified structure as produce of geothermal deposits, c) capacity building like muslim house of worship masque, community stall with the associated with herbal plantation as biodiversity, d) infrastructure the completed of rest area which Banyan tree as shade tree of tourist

Several locations along this active fault have not only biodiversity which is present along the active fault of the Siulak segment, but does not close it is also possible that there are local cultures that are stored, and of course they must be requires further research. More then half locations along active fault this has been used as a tourist attraction such as in the geothermal manifestation of Semurup and also the geothermal manifestation of the Sungai Medang. Another location that is not inferior interesting is the volcanic landscape complex, because consists of a complex of current and ancient volcanoes. However it should be noted that there are consequences of such use, that the related to path of rock mass movement, subsidence surface. So the need for mitigation through geological disaster mitigation efforts.

Semurup geothermal features manifestation has 75°C - 94°C, pH 7 – 7,6, appear on the residual silica sintere and hydrothermal alteration of volcanic product. The existence of geothermal features manifestation is believed to be the result of volcanic geothermal the associated of the Siulak fault segment. The criteria on this site based on geodiversity as produce of Quarternary volcanic and hydrothermal alteration, basin landscape of

Sungai Penuh Basin, Siulak fault segment. Biodiversity has Banyam tree, herbal plantation geothermal manifestation surrounding. Cultural diversity with capacity building and infrastructure of Jambi custom/tradition house as well as local wisdom. This site have been being integration geodiversity, biodiversity, and cultural diversity. When we visit this site, we listen to traditional music that will accompany you during your trip.

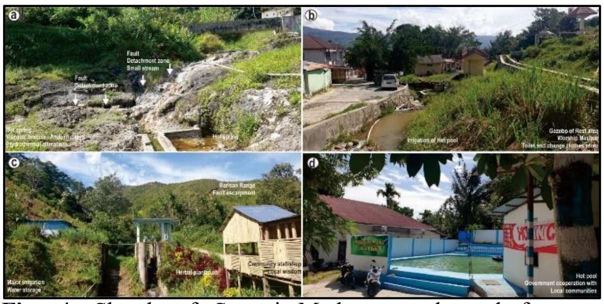

Fig. 4. Sketch of Sungai Medang geothermal features manifestation. a) volcanic breccia with the appearance of hot spring the related to fault detachment zone of Siulak segmented, b) infrastructure like gazebo of rest area, worship masque, equipped with toilet and change clothes room, c) major irrigation as intermixing of natural water and geothermal manifestation the equipped of water storage the surrounding it growing herbal plantation, community stall made of wood around geothermal manifestations with the shape of the house adopting local wisdom, d) artificial bath hot pool from hot spring geothermal manifestation, this is collaborative effort of government and local community

In the collection and identification of geodiversity that has been carried out, obtained from four different locations, covering Panorama Peak (Fig. 5), Semurup Hot Springs, Sungai Medang Hot Springs, Valleys to Kerinci Lakes (Fig. 6) that is around the research area.

Fig. 5. View of the Panoram Peak. a) overview of Kerinci Mountain which mountain complex like Tujuh Mountain and Melintang Mountain, on the valley of Sungai Penuh Basin the associated with Siulak fault segmented, seen from southern on the Panorama Peak, b) Runcing and Melintang Mountain with Siulak fault segmented, this site has characteristic biodiversity, that is cinnamon tree, banana tree, c) infrastructure completeness that could be used as a photos spot with a natural background, d) landscape of Barisan Range, north facing camera

Fig. 6. Representation view of Kerinci Lake. a) Kerinci Lake seen from the western - southwestern part of lake, b) Lake Kerinci seen western part of lake. This site stratigraphic composed is ignimbrite product

Sungai Medang geothermal features manifestation has 55°C - 78°C, pH 8 – 8,1, appear on the volcanic breccia and andesitic lava have been hydrothermal alteration. The existence of geothermal features manifestation is believed to be the result of volcanic geothermal the associated of the Siulak fault segment. The criteria on this site based on geodiversity as produce of Quarternary volcanic and hydrothermal alteration, basin landscape of Sungai Penuh Basin, Siulak fault segment. Biodiversity has teak tree, betel nut tree, herbal plantation geothermal manifestation surrounding. Cultural diversity with capacity building and infrastructure of Jambi custom/tradition house as well as local wisdom. This site has been being integration geodiversity, biodiversity, and cultural diversity. When we visit this site, we listen to traditional music that will accompany you during your trip.

Panorama Peak has stratigraphic consist of pyroclastic flow Quartenary volcanic product of Raya Mountain and other related volcanic like Talang Mountain. The wonderful of the volcanic landscape part of Barisan Range have a value of geohistory. Biodiversity is spatial relationship to geodiversity as indication better criteria to become geological site, the part of geopark aspect. The Siulak fault segmented seen presence along wedge of Sungai Penuh Basin nad Barisan Range. Geodiversity is directly proportional to biodiversity, and also cultural diversity. This site we will hear traditional music when we visit. Treats beautiful natural sceenary, coffee resto, and resort are part of the infrastructure that must be available in tourist site.

Kerinci Lake is is believed to be a lake formed by volcanic and tectonic activity from the Sumatran Fault System. Kerinci Lake and Sungai Penuh Basin are a single basin unit formed as a result of fault mechanism ingle *Fault-bend basin* reference [14, 15]. Biodiversity like coconut tree, sedimentation processes on wedge of lake have been sedimentary deposit the growing up of biodiversity. Besides that, it is used as a fish cage by local community as local wisdom on integration of geodiversity, biodiversity, and cultural diversity.

5 Discussion

Geotourism site is one of the efforts for the conservation of geological heritage. So that, the research detailed to Siulak Fault segment plays an important role in the presence of geodiversity in Sungai Penuh for the proposed geological site become complete information between the integration of geodiversity, biodiversity, and cultural diversity. The consequence of Siulak segmented part of Sumatra Fault System of the existence of the fault is being in a geological hazard and risk zone, especially from the danger of earthquakes and landslides, or even liquefaction. There are four locations proposed as geotourism, include by Semurup Hot

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Springs, Sungai Medang Hot Springs, Kerinci Lake, and Panorama Peak (Fig. 7).

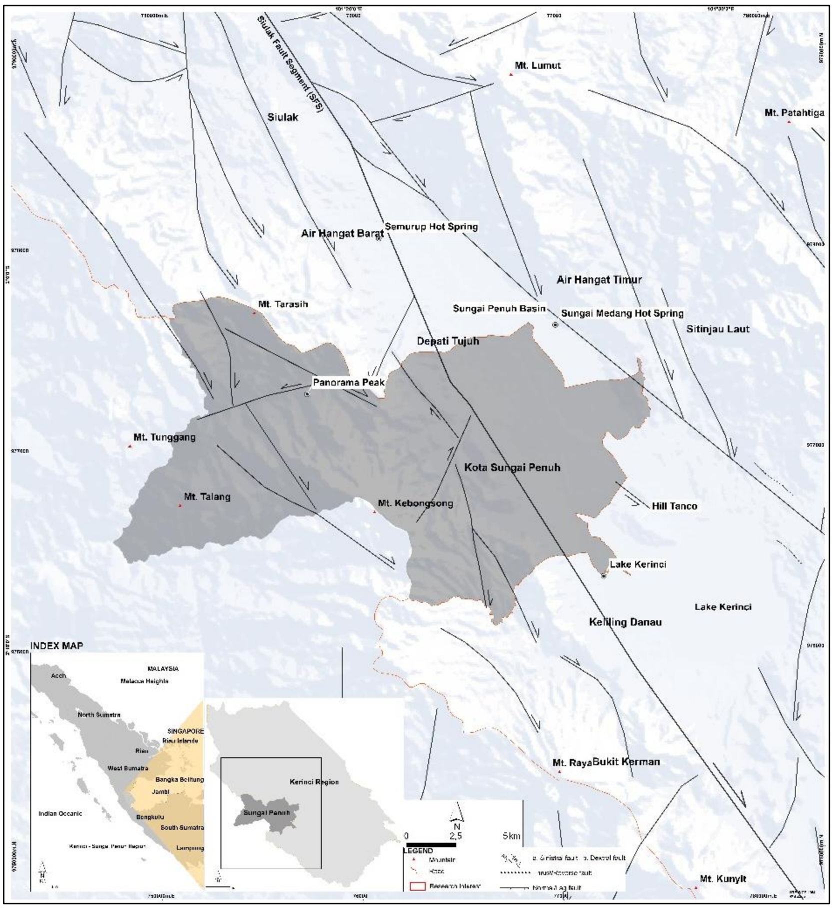

Fig. 7. Geotourism site proposed in the Sungai Penuh and Vicinity. Tanco Hill and Sungai Penuh Basin are potential geotourism further. Structural geology based on measured structural geology in the field, regional geology, and interpretation of DEM

Based on field data and integration to DEM analysis are the presence of the Siulak segmented fault structure associated with geodiversity and biodiversity as seen in the four proposed geotourism sites. Therefore, an effort to exploit the potential of the active fault in the Siulak segmented by conserving geological heritage, which includes aspects of biodiversity and cultural diversity, which require of policy regulation, infrastructure, and capacity building (Fig. 8).

Actually, with this geological heritage conservation effort, it is necessary to know that this zone is in the path of geological hazard from active faults such as earthquakes and landslides or mass movement, so that geological disaster mitigation efforts are needed in the use of a geo-tourism site. So that the geo-tourism site that built based on sustainability development.

The geodiversity provides a demand for tourism-loving communities to preserve geological heritage in the concept of geological conservation to be proposed as a geo-tourism site. So that, this role can be later have a positive impact on the community around geo-tourism objects based on sustainable development. In this effort to conserve geological heritage, of course, geo-tourism objects must have a good impact on geo-tourists, such as making signboards about geo-tourism objects in the form of understanding storytelling.

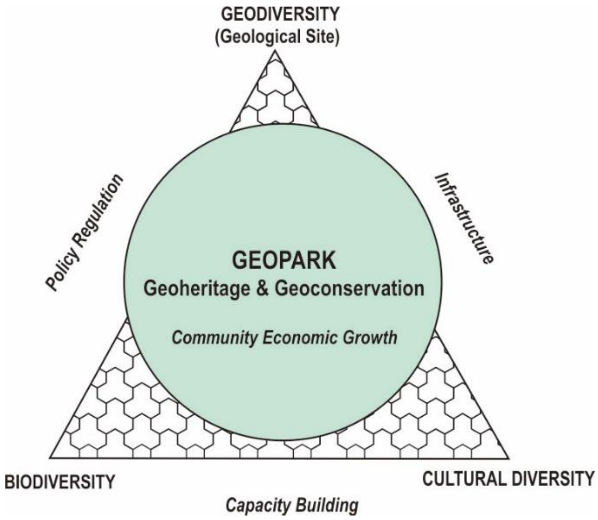

Fig. 8. Concept proposed in geotourism site submission for aspiring geopark

6 Conclusion

1) The Siulak fault segment has role important the presence of geodiversity and biodiversity along fault zone such as Semurup Hot Spring, Sungai Medang Hot Spring, Kerinci Lake, and Panorama Peak.

2) The consequence of Siulak fault segmented is the presence of geodiversity, such as geothermal features manifestation, geological landscape, and the mass movement as geological hazard. In the Sungai Penuh has geodiversity, which is Sungai Medang geothermal features manifestation, Semurup geothemal manifestation, Kerinci Lake landscape, Panorama Peak. Sungai Penuh Basin landscape, and Tanco Isolated hill will be submitted to geotourism site further.
3) In the proposed and using of geotourism site in the future, things that need to be considered are geological disasters through efforts to geological disaster mitigation.
4) The geodiversity provides a demand for tourism-loving communities to preserve geological heritage in the concept of geological conservation to be proposed as a geotourism site. So that, this role can be later have a positive impact on the community around geotourism objects based on sustainable development.
5) Effort to geological conservation and geological heritage, of course, geotourism objects must have a good impact on geotourists, such as making signboards about geotourism objects in the form of understanding storytelling.

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