

Analisis Umur Pelapukan Sampel Tanah Sekitar Goa Seropan - Yogyakarta

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Sari, telah dilakukan analisis ^{14}C sampel tanah yang berasal dari sekitar Seropan Gunung Kidul, Yogyakarta. Analisis ^{14}C terhadap sampel tersebut dilakukan dengan tujuan mengetahui umur pelapukan dan laju pelapukan batuan gamping menjadi tanah. Analisis dilakukan menggunakan teknik penanggalan karbon, di mana dapat diketahui aktivitas dan umur pada tiap lapisan. Pengambilan sampel dilakukan pada kedalaman 10 cm, 20 cm dan 30 cm masing-masing sebanyak 1 kg. Hasil analisis menunjukkan bahwa umur pelapukan tanah pada masing-masing kedalaman tersebut sebesar 3100 ± 15 , 3860 ± 15 dan 5000 ± 20 . Dari hasil umur dan jarak antar lapisan, maka diketahui bahwa laju pembentukan tanahnya sebesar 0,114 mm/tahun.

Kata Kunci: kronologi, umur pelapukan, analisis ^{14}C , tanah, Seropan

Abstract, the analyzes ^{14}C have been carried from soil samples around Seropan Gunungkidul, Yogyakarta. ^{14}C analysis of the samples was carried out in order to know the age of weathering and the rate of weathering of limestone rocks into soil. Analyses were performed using carbon dating techniques, which can be known activity and age on each layer. Sampling was conducted at a depth of 10 cm, 20 cm and 30 cm respectively as much as 1 kg. The analysis showed that the age of the weathering of land on each of these depths of 3100 ± 15 , 3860 ± 15 and 5000 ± 20 . From the age and the distance between the layers, it is known that the rate of soil formation of 0.114 mm / year.

Key words: chronology, age wethering, analyzes ^{14}C , soil, Seropan

which span around Lake Ranau areas. The area was already a settlement for a long time as we can found a temple from classical era at Jepara, by its type the temple dated from early classic era and had same ornaments as temples in Central and East Java from around 9th and 10th century AD.



Figure 7. Hujung Langit inscription

In Bawang area there is an inscription knows as Hujung Langit which according to Damais (1962) came from 919 C or 997 AD and Javanese influence can be seen in its dating method. Furthermore Damais connect the Javanese dating method in the inscriptions with Javanese's expedition to Srivijaya which according to Chinese sources happened in 992 - 993 AD. His conclusion was that the Javanese influence found at the inscriptions was proof of Javanese occupation in Lampung in accordance with Chinese sources (Guillot, et al, 1996: 116).

According to Kota Kapur inscription there's no Javanese influence in Ranau Lake area, but opinions that the area already was settled for a long time before Hujung Langit inscription and Jepara Temple can be accepted if there's enough data to back it up. Hypothesis that said *Bhumi Jawa* was located in Lampung still need more data to verify which can be found either at Ranau Lake, Martapura or South Sumatera, but surely not in Lampung.

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yang baik. Faktor lainnya yang menjadi alasan kedua metode tersebut mulai ditinggalkan adalah biaya bahan yang cukup tinggi, terlalu lamanya proses analisis dan masalah keselamatan yang kurang terjamin (Qureshi, R. M., et al., 1989 dan Kuk, L., et al., 1997)

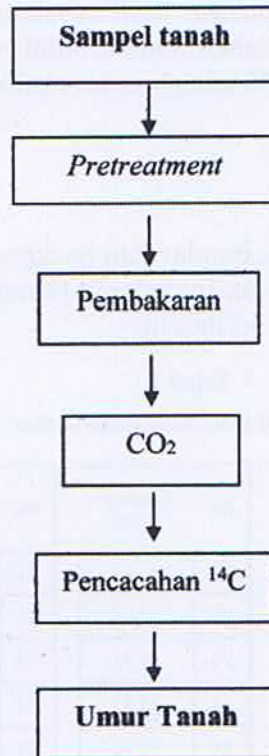
Dengan latar belakang seperti itu, dikembangkan dan diterapkan metode baru yang lebih menjamin keselamatan kerja, yaitu metode *absorpsi CO₂*. Metode ini merupakan alternatif terhadap metode sintesis benzena yang pada dua dekade terakhir ini terus dikembangkan dan digunakan oleh banyak peneliti. Cara kerjanya adalah dengan mencacah CO₂ yang terserap oleh larutan absorber. Melalui teknik ini paling sedikit lima sampel sehari dapat dianalisis dengan preparasi sampel yang lebih singkat. Penggunaan metode absorpsi dapat menentukan umur hingga 35.000 tahun.

Metode absorpsi CO₂ sering disebut juga metode *direct counting ¹⁴CO₂*, karena aktivitas sampel ¹⁴C dalam CO₂ langsung dicacah dan kemudian dikonversi menjadi umur. Analisis sampel dengan metode ini melibatkan pemakaian absorpsi kimia CO₂ yang pada umumnya tersedia dalam bentuk larutan Carbosorb dan larutan sintilator. Setelah proses absorpsi, sampel ditempatkan dalam vial gelas untuk kemudian dicacah aktivitas ¹⁴C-nya. Jumlah karbon yang terserap secara normal ditentukan berdasarkan perbedaan bobot di antara jumlah larutan absorber (Sintilator/Carbosorb) yang diketahui dengan CO₂ yang terserap di dalam larutan tersebut (Nair, A. R., et al., 1995 dan Aravena, R. O., 1989).

Hasil pengukuran yang dihasilkan dengan menggunakan metode absorpsi CO₂ dapat menghemat lamanya analisis sampel, bila dibandingkan dengan metoda sintesis benzena yang telah digunakan selama ini di banyak laboratorium pertanggalan karbon. Diagram alir di bawah ini akan memberikan gambaran mengenai perbedaan tahapan analisis di antara kedua metode tersebut dengan perbandingan pada gambar 1.

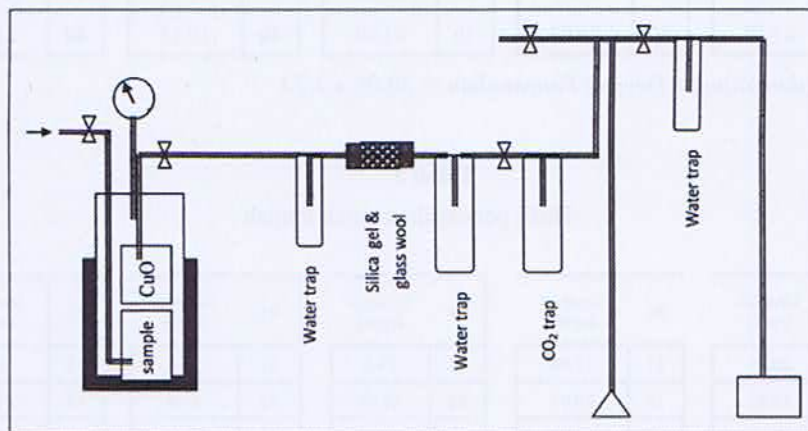
Penerapan metode pertanggalan menggunakan metode absorpsi CO₂ dilakukan melalui sampel tanah yang berasal dari lapisan permukaan Goa Seropan, Desa Semuluh, Kecamatan Semanu, Kabupaten Gunung Kidul, DI Yogyakarta yang diambil dari kedalaman antara 10, 20, dan 30 cm. Analisis sampel dilakukan di Pusat Aplikasi Teknologi Isotop dan Radiasi (PATIR), Badan Tenaga Atom Nasional, Pasar Jumat, Jakarta Selatan. Pengambilan sampel stalaktit dilakukan pada tanggal 25 November 2011 sedangkan analisis sampel dilakukan mulai dari tanggal 19 Maret 2012 sampai dengan tanggal 22 Maret 2012. Dari analisis yang dilakukan, diharapkan dapat menjawab tentang laju pembentukan tanah di masa lalu.

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Gambar 2. Diagram proses analisis ^{14}C dengan teknik pembakaran

Rangkaian alat CO_2 untuk analisis ^{13}C dan ^{14}C dengan teknik pembakaran dapat dilihat pada gambar berikut,



Gambar 3. Rangkaian alat CO_2 untuk analisis analisis ^{14}C dengan teknik pembakaran

6	20.44	16	19.64	26	17.73	36	20.9	46	17.4
7	20.57	17	21.07	27	19.86	37	20.82	47	20.02
8	21.26	18	21.24	28	21.27	38	23.69	48	19.36
9	21.67	19	22.35	29	18.94	39	20.36	49	18.98
10	21.64	20	21.81	30	18.07	40	20.31	50	22.12

Rerata dan Standar Deviasi Pencacahan = $20,29 \pm 1,30$

Tabel 3.

Hasil pencacahan tanah bawah

No.	Cacahan (cpm)	No.	Cacahan (cpm)	No.	Cacahan (cpm)	No.	Cacahan (cpm)	No.	Cacahan (cpm)
1	23.85	11	19.88	21	19.65	31	18.36	41	19.6
2	19.45	12	20.47	22	20.88	32	20.42	42	17.93
3	18.87	13	17.24	23	18.19	33	19.67	43	19.55
4	20.04	14	18.26	24	19.35	34	18.61	44	19.7
5	19.84	15	19.61	25	20.97	35	20.1	45	18.9
6	18.02	16	19.36	26	18.52	36	17.95	46	19.78
7	19.25	17	19.64	27	19.91	37	18.16	47	19.61
8	18.44	18	16.57	28	20.03	38	17.84	48	22.05
9	19.12	19	18.96	29	19.95	39	19.65	49	19.08
10	19.62	20	19.93	30	19.41	40	19.82	50	18.06

Rerata dan Standar Deviasi Pencacahan = $19,36 \pm 1,18$

Tabel 4

Hasil pencacahan sumber standar

No.	Cacahan (cpm)	No.	Cacahan (cpm)	No.	Cacahan (cpm)	No.	Cacahan (cpm)	No.	Cacahan (cpm)
1	21.73	11	22.79	21	19.62	31	21.12	41	21.74
2	21.19	12	20.10	22	19.74	32	20.79	42	19.73
3	20.50	13	20.13	23	21.42	33	22.38	43	20.20
4	19.50	14	20.13	24	22.60	34	21.33	44	21.19
5	20.53	15	19.94	25	22.08	35	21.57	45	21.32
6	22.99	16	20.01	26	20.23	36	21.87	46	21.99
7	20.20	17	18.18	27	21.76	37	21.92	47	21.90
8	20.79	18	21.01	28	20.41	38	20.55	48	19.54
9	22.32	19	21.83	29	21.18	39	20.82	49	20.94
10	17.93	20	21.63	30	22.59	40	19.17	50	22.63

Rerata dan Standar Deviasi Pencacahan = $20,96 \pm 1,13$

Dari hasil perhitungan diperoleh umur tertua dari sampel ini adalah tanah bawah dengan umur 5000 ± 20 tahun dan mempunyai nilai pMC sebesar $54,36 \pm 1,83$. Sedangkan umur termuda didapatkan pada sampel tanah atas dengan umur 3100 ± 15 dengan nilai pMC sebesar $67,97 \pm 2,14$. Sampel tanah tengah berumur 3860 ± 15 tahun dan nilai pMC sebesar $61,84 \pm 3,58$.

Setelah mengetahui umur dari masing-masing sampel, maka laju pembentukan lapisan tanah dari proses pelapukan dapat diketahui dengan membandingkan jarak antar sampel tanah dengan selisih umur dari tiap sampel. Perhitungan ini menunjukkan bahwa rata-rata laju pembentukan tanah di sekitar Seropan sekitar $0,114$ mm/tahun. Laju pembentukan tanah di seluruh dunia berkisar antara $0,01$ hingga $7,7$ mm/tahun. Jika dibandingkan dengan laju pembentukan tanah di seluruh dunia, laju pembentukan tanah di Goa Seropan masih dalam cakupan rata-rata pembentukan tanah di dunia. Hal ini disebabkan oleh berbagai macam faktor di antaranya iklim, kelembaban, organisme yang hidup di atas permukaan tanah dan juga sistem pengolahan tanah di daerah tersebut.

Simpulan

Berdasarkan hasil analisis yang dilakukan terhadap sampel tanah yang diambil dari Goa Seropan, Yogyakarta yang dilakukan dengan menggunakan metode absorpsi CO_2 , dapat diperoleh beberapa simpulan sebagai berikut.

1. Besar *Percentage of Modern Carbon* (pMC) yang terbesar adalah sampel tanah pada kedalaman 10 cm dari permukaan yaitu sebesar $67,971 \pm 2,146$ % sedangkan yang terkecil adalah sampel tanah pada kedalaman 30cm yaitu sebesar $54,3652 \pm 1,834$ %.
2. Umur pelapukan tanah pada penelitian ini yang tertua adalah sampel pada kedalaman 30cm dengan umur $4895,67925 \pm 275,69$ sedangkan umur pelapukan termuda adalah sampel pada kedalaman 10 cm dengan umur $3101,394 \pm 257$.
3. Rata-rata laju pembentukan tanah pada penelitian ini adalah $0,114$ mm/tahun.

Tentunya metode ini ke depan dapat diterapkan pada penelitian arkeologi yang memerlukan pengkajian yang lebih mendalam pada situs-situs yang kadangkala membutuhkan kajian yang bersifat multi disiplin, terutama dalam mengkaji tentang bagaimana kronologi dan perubahan yang terjadi di masa lalu.

Some Consideration on Location of “Bhumi Jawa”

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Sari, daerah Lampung pernah menjadi wilayah kekuasaan Sriwijaya. Prasasti Palas Pasemah dan prasasti Bungkok merupakan prasasti yang dikeluarkan Sriwijaya yang ditemukan di Lampung. Pada prasasti Palas Pasemah disebutkan bahwa Sriwijaya akan menyerang Bhumi Jawa. Nama Bhumi Jawa juga disebutkan dalam prasasti Kotakapur yang ditemukan di Pulau Bangka. P.V. van Stein Callenfels dan Buchari berpendapat bahwa Bhumi Jawa merupakan lokasi yang ada di Lampung. Di Lampung terdapat dua lokasi yang bernama Bumi Jawa, yaitu di daerah Lampung Timur dan Lampung Barat. Bumi Jawa di Lampung Timur merupakan permukiman masyarakat marga Nuban dari klan Abung Siwa Mega. Tradisi lisan masyarakat menyebutkan bahwa mereka berasal dari daerah Sekalabrak yaitu di sekitar Bukit Pesagi hingga Danau Ranau. Masyarakat Bumi Jawa di Lampung Barat adalah marga buay Nyerupa yang termasuk dalam Paksi Pak Sekalabrak. Tinggalan arkeologi di situs Gedongdalem, Bumi Jawa, Lampung Timur menunjukkan bekas permukiman dari sekitar abad ke-14. Sedangkan di Bumi Jawa Lampung Barat terdapat situs permukiman yang mengandung ciri budaya megalitik. Selain itu di kawasan sekitar Gunung Pesagi hingga Danau Ranau juga banyak terdapat tinggalan dari masa klasik seperti prasasti Hujung Langit dan Candi Jepara. Dengan demikian, mungkin Bhumi Jawa yang disebut dalam prasasti Kota Kapur dan Palas Pasemah berada di wilayah sekitar Gunung Pesagi hingga Danau Ranau.

Kata Kunci: *Bumi Jawa, Prasasti Palas Pasemah, Prasasti Kota Kapur, Tapak Siring*

Abstract, *Initially Bhumi Jawa in some of Srivijaya inscription was considered as settlement of Javanese migrants in Lampung, but knows it's known that Bumi Jawa in Sukadana area in lived by ingenious peoples of Lampung. The settlement of Bumi Jawa in Sukadana begin at around 14th century AD and as the Kota Kapus and Palas Pasemah inscriptions came from 7th century AD there's hardly any connections. But Bumi Jawa communities in Sukadana were migrants and always take their settlement name to the new area had to come*

of Lampung by Srivijaya, in it there's also a phrase about *Bhumi Jawa* that didn't obey or yield to Srivijaya, note about *Bhumi Jawa* can also found in Kota Kapur inscription. In term of palaeographic the inscriptions come from 7th century AD (Boechari, 1979: 19-40).



Figure 2. Kota Kapur inscription

Kota Kapur inscriptions found at Menduk River basin in Bangka Island contain curses to whom that done evil and not loyal to the king, there's also notes about Srivijaya expedition to conquer *Bhumi Jawa*. According to P. V. van Stein Callenfels "jawa" in the inscription means outside, thus the inscription was to commemorated Srivijaya conquering expedition (Sumadio, 1990: 58-59). About this subject Boechari (1986: 33-56) had other opinion, he think the inscription was about Srivijaya conquering Lampung, thus *Bhumi Jawa* location can be found in Lampung area not on Java Island.

Result from contemporary research done at Batujaya suggest that *Bhumi Jawa* is indeed Java Island but there's an area in Lampung that also named Bumijawa habituated by ingenious people of Lampung. There were also probabilities that *Bhumi Jawa* in Palas Pasemah and Kota Kapur inscription revering to that particular area in Lampung.

Settlement remains of Bumijawa communities in East Lampung still can be seen at Gedongdalam sites, located north of Batang Hari River at 5°03' South and 105°25' East. The site is about 2000 square metres, and to east and west of the area there's moat act as settlement border. The sites now is a corn field with shards of china and pottery scattered on the ground, people who works on the land often found Chinese coins.

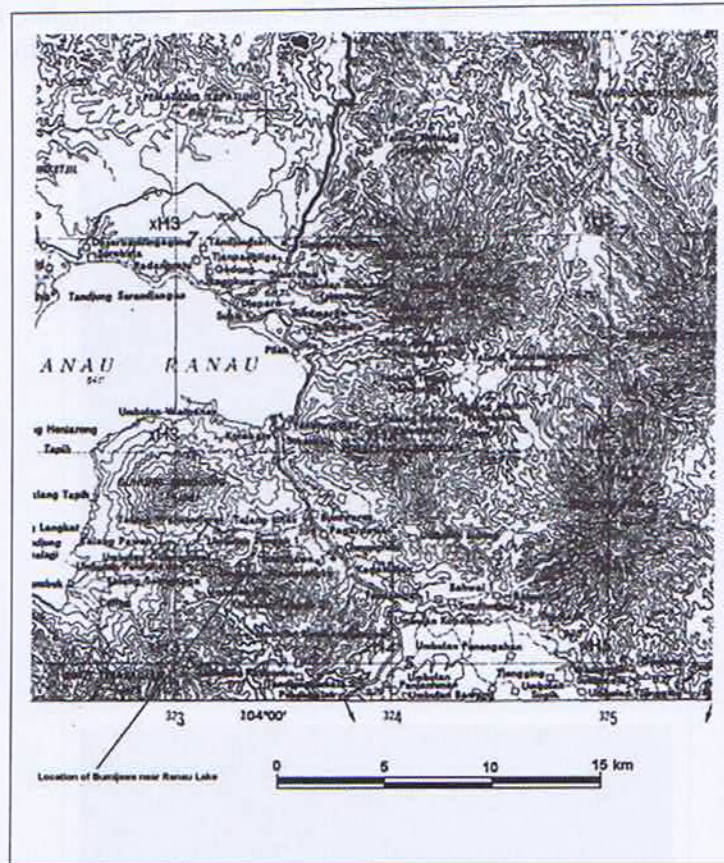


Figure 4. Map of Bhumijawa in West Lampung

On the west moat there were three dirt mounds with north - south orientation. The south most mounds is 2 m high and around 3 m in diameters known as the tomb of Midah, wife of Minak Nyaringgem, it's covered by shrubs and didn't have stone of wood as a sign. Eight meters to the north there's another tomb, this one belong to Putri Bagus -the daughter of Menak Nyaringgem-. The 1 m high and 2 m diameters mound is also covered by grass and shrubs. The last tomb with 2 m high and 4 m in diameters belong to Menak Nyaringgem himself, this mound is covered with bamboo groove. On top of it there are some stone on the ground.

Tapak Siring site located at Bukit (hill) Katai in Kunayan hamlet, Tapak Siring village. It's on a hilltop with cliff and moat as the border with north – south orientation, on it there are two stone –called *kasai* by the locals-. The first stone is 0.7 by 0.7 by 1 m in dimensions and the second one is 0.25, 0.6 by 0.8 m. The first one located on the south side of the hilltop and the second one is north of it. Chicken feet and Buffalo hoofs impressions are one the first stone, on the ground around the stones also can be found fragments of ceramics from Song Dynasty.

Toms of Adipati Sebrak Bumi and his spouse located also on the slope of Bukit Katai, he's considered as one of ancestor of the Buay Nyerupa. *Sebrak* in Lampung language means expanse and *bumi* means land, so the name literally means broad land/expanse land belong to Adipati Sebrak Bumi.

Toms of Sebrak Bumi is square in shape with 5.5 by 5.5 m in dimensions and was finished in 2003. It got North West – South east orientation and has head stone 0.29 m long, 0.20 m wide and 0.18 m in depth, the South east stone is 0.34 m long, 0.12 m wide and 0.22 m in dept. Distance between both stone are 2 m, the tomb is covered in ceramics with overall dimension of 2.4 by 0.60 by 0.35 m.

Wife of Adipati Sebrak Bumi tomb located west of his, have same orientation and marked with head stones, 0.28 by 0.13 and 0.2 cm and 0.17 by 0.10 and 0.07 cm. Distance between the stones are 1.6 m, covered in ceramics with overall dimension of 2 by 0.40 and 0.35 m.

Family in Lampung Communities

Bumijawa is connected with Marga Nuban and Buay Nyerupa communities, Marga Nuban is one of the family belong to Abung Siwa Mega Clan and Buay Nyerupa is one of "buay" (a community within one family) in Paksi Pak Sekalabrak. Traditional rules in form of "marga" (family) according to Ahmad Kesuma Yudha, quoting J. W. Naarding (Yudha, 1996: 3) was known after the fall of Tulangbawang. Vacant position of a ruler in Lampung was use by Srivijaya to rule the area and introduce "marga" traditional governing system that continually used until Bantam taking over as ruler of Lampung.

Research by Hilman Hadikusuma in 1989 (1989: 157) come up with a slightly different result he said "marga" system was begins in 17th or 18th century. Before that traditional government in Lampung known as *keratuan*, several of this "keratuan" in 17th or 18th century form an organization based on *buay* (relatives) known as *paksi* (several *buays* or clan) and *marga*, (part of *buays* in form of villages)

Another research was done by Mintosih (1993: 42 – 45) had result as follows; marga system was introduced and used by Srivijaya as means to

sites and the existence of "batu dakon", conclusion that came up is both the sites came from pre Islamic era.

As for Tapak Siring site, it's also bordered by dirt walls and manmade moats. In this site megalithic cultures can also seen from stones that had manmade depression and marks on its surface, the stone known as "batu kasai" by locals.

Megalithic remains can also be found in West Lampung, such as at Tapak Siring site and others sites around Ranau Lake. Those remains are in form of menhirs, Flat Stone, Carved Stone, Stone Enclosure, Dolmens, and Carved Dolmens. Shards of ceramics and pottery also had been found at those sites.

Experts like Robert von Heine Geldern (1945), Heekeren (1958), and Soejono (1981) believes that the term megalithic is not revering to a certain era or cultures but more like a tradition that evolved from Neolithic era thru steel and copper era up until now at some places (Prasetyo, 2004: 95). Megalithic tradition were universal, it's found all over the world except for Australia (Bellwood, 1975: 281-380; Soejono, 1984: 242)

Etymologically megalithic came from Greek words Mega which mean big and Lithos which mean stone thus megalithic mean a tradition that use and made big stone objects. In the other hand, objects found at the fields often didn't correspond with that term. As F. A. Wagner said, megalithic concepts were not revering to big stones in particular as small stone or no stone at all can be said to had megalithic characteristics but more to divine ways to worships ancestors (Wagner, 1962: 72).

For some experts megalithic cultures was identified with ancestor worships, like Geldern that said a megalithic structure can be linked with the underworld, to ensure safe journey for the death and safe and prosperous life for the living (Geldern, 1945: 149). Influence of this tradition can be seen by the way societies look at the ways of live can effects live after death (Soejono, 1977: 195).

Initially *Bhumi Jawa* in some of Srivijaya inscription was considered as settlement of Javanese migrants in Lampung, but knows it's known that Bumijawa in Sukadana area in lived by ingenious peoples of Lampung. The settlement of Bumijawa in Sukadana begin at around 14th century AD and as the Kota Kapus and Palas Pasemah inscriptions came from 7th century AD there's hardly any connections. But Bumijawa communities in Sukadana were migrants and always take their settlement name to the new area had to came into considerations.

Based on ethno historic Bumijawa communities came from Bukit Pesagi and before that area around Martapura, these areas know known as Sekalabrak

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