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Dryobalanoxylon sp. : Silicified Fossil Wood from Lebak Regency, Banten Province, Indonesia

Dryobalanoxylon sp. : Fosil Kayu tersilikakan dari Kabupaten Lebak, Provinsi Banten, Indonesia

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Abstrak- Fosil kayu *Dryobalanoxylon sp*. ditemukan pada dua lokasi di Desa Sindangsari, Kecamatan Sajira, Kabupaten Lebak, Provinsi Banten, Indonesia. Fosil kayu tersebut terawetkan dalam endapan batuan tufa, Formasi Genteng yang berumur Pliosen Awal dengan lingkungan pengendapan litoral-terestrial. Untuk mengetahui komposisi mineral fosil kayu dilakukan analisis XRD (*X-Ray Diffraction*). Hasil analisa XRD menunjukkan bahwa mineral yang terdapat dalam fosil kayu adalah kuarsa dengan nilai d masing-masing 3.358 Å dan 3.350 Å

Katakunci : *Dryobalanoxylon*, Pliosen awal, Formasi Genteng, Kuarsa

Abstract- *Two fossil wood were discovered from Sindangsari Village, Sajira District, Lebak Regency, Banten Province, Indonesia. They were preserved within tuffaceous rocks of the Genteng Formation in Early Pliocene age in littoral to terrestrial environment deposition. To identify mineral composition of the silicified wood, XRD analyser method was applied. The result of XRD analyses shows that both of fossil woods are Dryobalanoxylon sp. consisting of quartz mineral with d value is 3.358 Å and 3.350 Å*

Keywords *: Dryobalanoxylon, Early Pliocene, Genteng Formation, Quartz*

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INTRODUCTION

The discovery of fossil wood in Indonesia is one of common geological phenomenon but it is less known about further observation on its palaeoecological context. On the other hand, fossil wood becomes more popular, because it has a high value commodity. If this condition continously, the existence of fossil wood in Indonesia will be extinction.

Fossil wood has some critical informations such as ecological evolution (Wilis & Mc Elwan, 2002), palaeogeography and paleoclimate (Mehrota, et al., 1999; Tiwari et al., 2012; Bande & Prakash, 1986; Linch et al., 2015; Shukla et al., 2013; Yang et al., 2013; Wiemann et al., 1998).

Research on fossil wood in Indonesia started when Goppert in 1854 who has studied in Java (Krausel, 1925). Although, Crie (1888) has described wood fossil as a *Naucleoxylon spectabile* (Rubiaceae) from Gunung Kendeng (Jawa), however it was revised by Krausel (1926) became a *Dipterocarpoxylon spectabile*.

Previously, Krausel (1922a) found a *Dipterocarpoxylon javanense* in Bolang-Rangkasbitung and a *Dipterocarpoxylon sp.* in South Sumatera (Krausel, 1922b). However, Den Berger (1923 & 1927) argue that they were a *Dryobalanoxylon spectability* and a *Dryobalanoxylon javanense*.

Banten province is one of area in the island which has abundantly discovery of fossil wood. Fossil wood in this area is dominated by such as *Anisopteroxylon*, *Dipterocarpoxylon*, *Dryobalanoxylon*, *Hopeoxylon*, *Shoreoxylon*, *Parashoreoxylon*, *Cotylelobioxylon*, *Vaticoxylon* (Mandang & Martono, 1996; Andianto et al., 2015). Research on these specimens are commonly limited to anatomical characteristics without considering stratigraphy and minerals composition of fossil wood.

In Lebak Regency, fossil wood found in the Genteng Formation (Ansori, 2010; Winantris et al., 1994). Oktariani et al., (2017; 2018) has identified that fossil *wood Dryobalanoxylon sp.* has been found in 2 locations in Sindangsari. This paper will study mineral composition of *Drobalanoxylon sp.* which preserved in Sindangsari Village, Sajira District, Lebak Regency, Banten Province, Indonesia.

LOCATION AND GEOLOGICAL BACKGROUND

There are two *Dryobalanoxylon* fossil wood locations found in Sindangsari village. The first sample is situated in a coordinate S 6° 31' 23.9" E 106° 19' 50.6" with depth ± 150 cm from surface, and the second is situated in a coordinate S 6° 31' 26.6" E 106° 19' 47.0" with depth ± 320 cm from surface (Figure 1). The area belongs to Sindangsari Village, Sajira District, Lebak Regency, Banten Province, Indonesia.

The Fossil fragments have been stored in the Bandung Geological Museum room storage, Geological Agency, Ministry of Energy and Mineral Resources Republic of Indonesia with Collection number MGB00033170 for fossil wood which found in site 1 and MGB00033171 for fossil wood which found in site 2.

Based on geological map of Leuwidamar Sheet (Sujatmiko & Santosa, 1992), the fossil wood includes into the Genteng Formation, it was deposited in a littoral to terrestrial environment (Figure 2).

Litho-stratigrafical unit of area consists of tuffaceous claystone, tuffaceous sandstone, and tuff with having different thickness. Fossil wood found in tuff layer, which has been weathered as paleosoil (Figure 3). The age of Genteng Formation is Early Pliocene (Sujatmiko & Santosa, 1992), however based on palynology study is Middle Miocene – Pliocene (Winantris et al., 1994).

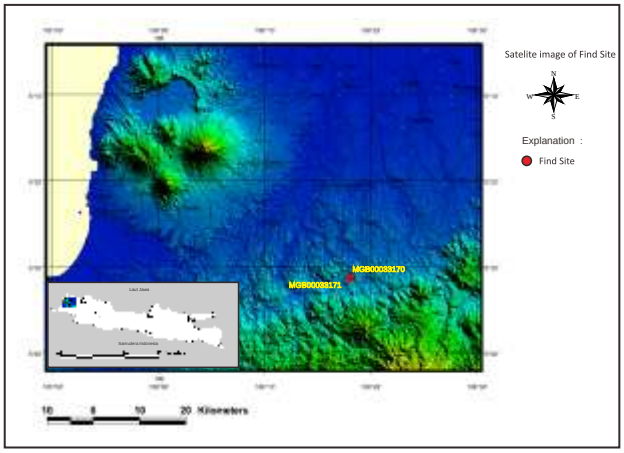
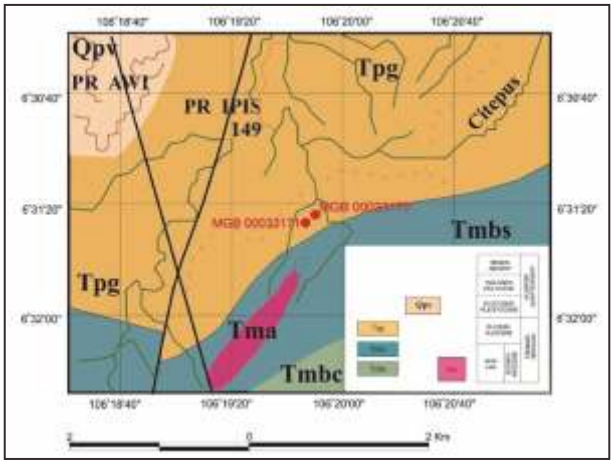


Figure1. Location of silicified wood fossils at Sindangsari Village, Sajira District, Lebak Regency, Banten Province, Indonesia.



sumber: Sujatmiko & Santoso, 1992

Figure 2. Finds site (●) in the geological map of Leuwidamar.

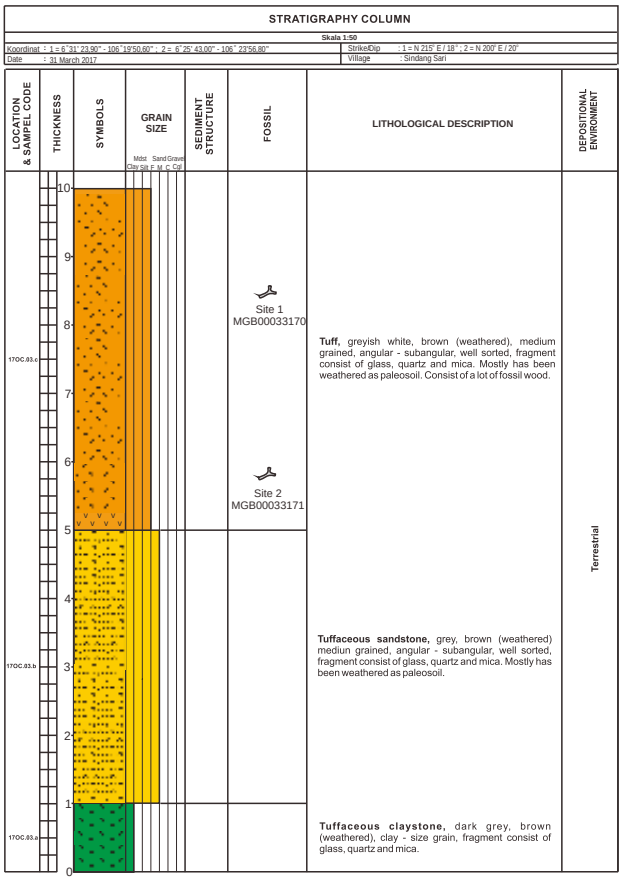


Figure 3. Stratigraphic column of fossil wood location

MATERIAL AND METHODS

Fossil wood specimen found in site 1 is white and brown in color. A specimen size ± 6 - 10 cm long and 22 - 23.5 cm in diameter. Fossil wood specimen found in site 2 is white and dark brown in color. A specimen fragment sized ± 5 - 5.5 cm long and 2 - 3.5 cm in diameter is secured to be observed into several thin sections and XRD analyzed.

Observation on mineral composition using X Ray Diffraction, Cu Ka / 40 k V/ 30 mA with X-Ray Diffractometer PANalytical X'Pert Pro PW3040/x0 in the laboratorium of Center for Geological Survey, Geological Agency, Ministry of Energy and Mineral Resources, Jl. Diponegoro No 57 Bandung.

RESULT AND DISCUSSION

Oktariani et al., (2017 and 2018) described that fossil wood found in Sindangsari, site 1 and site 2 was *Drobalanoxylon sp*, member of Dipterocarpaceae family. The discovery of *Dryobalanoxylon* in Indonesia has been frequently reported by several authors (Schweitzer, 1958; Mandang & Martono, 1996; Srivastava & Kagemori, 2001; Mandang & Kagemori, 2004; Andianto et al, 2015). *Dryobalanoxylon* diagnostic features has similarity with *Dryobalanops* (modern wood). Most of fossil wood has suffix – xylon, it is from Greek word which has definition wood or it has relation to wood (Oktariani et al, 2018).

Some features of *Dryobalanoops* not found in *Dryobalanoxylon*, because of fosilization process. Mustoe (2018) explained that the degree of anatomical preservation depends on relative rate of mineral precipitation and tissue destruction. Based on observation result, the diagnostic feature between MGB0033170 with MGB0033171 are different, eg; tracheid vaskicentric, which found in *Dryobalanoxylon* MGB00033170 is clearly, but not found in *Dryobalanoxylon* MGB00033171. On the other side crystal in rays found in *Dryobananoxylon* MGB00033171, but not found in *Dryobalanoxylon* MGB00033170. Comparison between *Dryobalanops* and *Dryobalanoxylon* mention in Table 1.

Observation mineral composition on fossil wood using XRD analysis. That mineral on fossil wood MGB00033170 is quartz, with d value 3.358 Å and MGB00033171 is also quartz, with d value 3.350 Å.

Buurman (1972) explained that mineralization of fossil wood divided into silicification, phosphatization, carbonization, and accumulations of sulphides. Silicification of wood, it may occur mainly in terrestrial process, carbonization may occur both under a marine and terrestrial circumstance. Phosphatized wood is exclusively from marine sediment, it will be occurred in a terrestrial under very special circumstances. Impregnation iron oxyde and hydroxyde may occur in a terrestrial environment while accumulation of sulphides is influenced by Eh and pH. Based on XRD result analyzed, mineralization in *Dryobalanoxylon sp.* (MGB0033170 and MGB0033171) including to silisification, with environtment depositional predicted as terrestrial.

Tabel 1. Comparison *Dryobanalops* and *Dryobalanoxylon*

Anatomical Features	*Dryobalanops*: Gaertner f. (Mandang and Martono, 2004)			*Dryobalanoxylon* sp.	*Dryobalanoxylon* sp.
	Desch, 1941	Chu., 1974	Ilic,1994	MGB 00033170 (Oktariani et al, 2018)	MGB 00033171 (Oktariani et al, 2017)
Wood					
Diffuse porous	+	+	+	+	+
Growth ring	+	-	-	?	?
Vessel					
Mostly solitary	+	+	+	+	+
Tangential diameter (µm)	182 (D.a) 181 (D.o)	180 - 232	130 - 3240 (160 - 220)	150 - 294 mean 219,786 ; std dev ± 29,484	122,22 - 229,96 mean 182,438; std dev ± 25,563
Frequency /mm2	8.9 (D.a) 7.7 (D.o)	.	5 (8-12) 17 5 (D.f) 17 (D.r)	4 - 8 mean 5,6 ; std dev ± 1,288	7 - 14 mean 9,657; std dev ± 1,781
Length (µm)				905, 44 - 5465,890 mean 2511,521 ; std dev ± 1250,99	513,61 - 1968,41 mean 1011,35; std dev ± 313,270
Tyloses	+	+	+	+	+
Tracheid vasicentrik	+	+	+	+	?
Parenchyma					
Diffuse in aggregates	+	+	+	+	+
Vasicentric incomplete	+	+	+	+	+
Aliform	tendency	+	tendency	?	?
Confluent	.	(+)	.	?	+
Banded	+	+	+	+	?
Rays					
Height (µm)	.	.	.	95, 55 - 2267, 090 mean 909,467; std dev ± 359,025	372,330-874,97 mean 622,334; std dev ± 127,583
Heterocelular	+	+	+	+	+
Marjinal cells	.	1-3	1-3	1-3	1-3
Sheath cells	.	(+)	(+)	1-3	+
Width, seriate	.	1-6	1-3-6	1-3 (4-8)	1-3 (4-8)
Resin canal, aksial					
Diffuse	.	.	.	.	.
Long tangensial rows	+	+	+	+	+
Diameter (µm)	< vessel	< vessel	40-70	49 - 217 mean 111,935; std dev ± 32,650	44-122 mean 69,800; std dev ± 19,059
Mineral Inclusion					
Silica in ray cells	+	+	+	?	+
Silica in parenchyma	.	.	D.b dan D.o	?	?
Crystals in parenchyma	+ (D.o)	(+) D.f dan D.r	(+) D.k., D.l.,	+	+
Crystal in rays			D.o., D.r	?	+

Remarks : *D.a = Dryobalanops aromatica; D.b = D. beccarii; D.f = D. fusca; D.k = D. keithii; D.l = D. lanceolata; D.o = D. oblongifolia; D.r = D. rappa*; + = present ; - = absent ; (+) = sometimes; . = no data; < = smaller

Other report describes that mineralization of petrified wood are commonly polymorphs of silicas : opal A, opal C, chalcedony and quartz. Non silica minerals such as calcium carbonate, calcium phosphate, varios iron, copper, manganese oxide, fluorite, barite, natrolite and smectite are less familiar (Mustoe, 2018). From the XRD result the mineral compostion on *Dryobalanoxylon sp*. (MGB0033170 and MGB0033171) is a common mineral on fossil wood. Opal A usually amorphus, Opat CT usually detected as cristobalite and trydimite, and chalcedony detected as cryptocrystalline quartz (Leo & Barghoon, 1976).

Leo and Barghoon (1976) hypothesized that there was a chemical affinity between wood and silica through hydrogen bonding, when wood permeated by silica solution, hydrogen bonding links silicic acid to hydroxyl groups on cellulose making up the inner cell wall. The progressive transformation of opal A to Opal CT to chalcedony and finally quartz is an important aspect of wood silicification. Scurfield and Segnit (1984) found when lithification occurs, silica may transform from one form to another by pseudomorphic replacement and /or repeated solution and recrystallization. In the specimens they studied, there is transformation from Opal CT to chalcedony and chalcedony to quartz, even the conversion of opal A to Opal CT was not strong. Mustoe (2008) concluded that petrification occurred in multiple processes. Some of specimens were permineralized with only opal CT, other were a combination of Opal CT and chalcedony and other were quartz. Quartz on *Dryobalanoxylon* (MGB0033170 and MGB0033171) showed that mineral already in stable form, although not clearly it is primary mineral or not.

Ansori (2010) reported that Opal CT in Lebak Regency caused by diagenesis process of Opal A which is influenced by increasing temperature and pressure in this area. Based on the lithology of the study area, the fossil wood was deposited in paleosoil which is the weathered tuff layer of the Genteng Formation. Tuff is a volcanic material with rich in silica content which predicted absorbed into wood tissue and preserved to be a fossil as describe by Matysova et al., (2010).

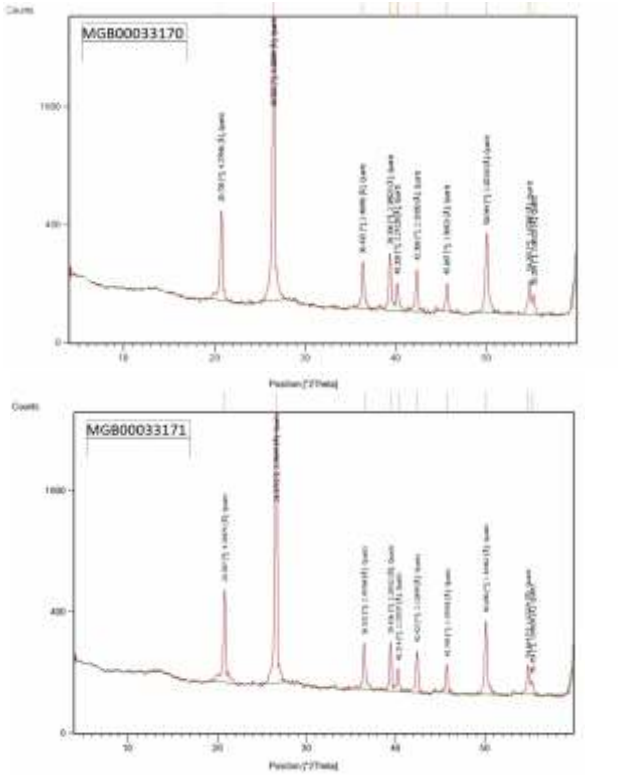


Figure 4. XRD analyzed result

Tabel 2. Identified patern list of fossil wood by XRD

Fossil wood	Ref. Code	Score	Compound Name	Displacement [°2Th.]	Scale Factor	Chemical Formula
MGB0033170	01-083-0539	84	Quartz	0.000	0.922	Si O2
MGB0033171	01-070-3755	92	Quartz	0.000	0.977	Si O2

CONCLUSIONS

The fossil wood MGB00033170 and MGB00033171 that know as that *Dryobalanoxylon sp*, where preserved in the Genteng Formation is silicified fossil wood. It is known based on XRD result analyzed, that mineral composition on fossil wood quartz with d value is 3.358 Å and 3.350 Å. The observation result shows that the diagnotic features of MGB0033170 with MGB0033171 are different where tracheid vaskicentric of *Dryobalanoxylon* found in MGB0033170 is clearly identified but non in MGB0033171.

The silica minerals have been absorbed into woody tissue during diagenetic processes.

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