

4

by Asmita Ahmad

Submission date: 06-Jun-2022 07:59AM (UTC+0700)

Submission ID: 1851065848

File name: ani_2021_IOP_Conf._Ser._Earth_Environ._Sci._807_042061_1.pdf (752.58K)

Word count: 3372

Character count: 17306

PAPER · OPEN ACCESS

4

The Potential estimation of soil fertility based mineral types in Papalang areas, Mamuju Regency, West Sulawesi

To cite this article: I Suryani *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **807** 042061

5

View the [article online](#) for updates and enhancements.



ECS **240th ECS Meeting**
Oct 10-14, 2021, Orlando, Florida

**Register early and save
up to 20% on registration costs**

Early registration deadline Sep 13

REGISTER NOW

The Potential estimation of soil fertility based mineral types in Papalang areas, Mamuju Regency, West Sulawesi

I Suryani¹, C Lopulisa² and A Ahmad²

¹Faculty of Agriculture and Technology, Cokroaminoto University
Jl. Perintis Kemerdekaan KM. 10 Tamalanrea Makassar 90245, Indonesia

²Soil Science Department, Faculty of Agriculture, Hasanuddin University
Jl. Perinis Kemerdekaan KM. 10 Tamalanrea, Makassar 90245, Indonesia

E-mail: idasuryani8311@gmail.com

Abstract. Commonly mineral is the soil inorganic material composed of various chemical elements. They become an important source of plant nutrients. The research objective is to determine the soil's physical properties and microscopically identified, including color, form, mineral shape, size, and quantity. A soil sample was taken at the top layer (0-20 cm) and bottom layer (20-50cm). We determine the types of minerals and identify nutrient-carrying minerals to assess soil fertility level in the Papalang areas, Mamuju Regency, West Sulawesi. This research's methods are the survey by observing and describing soil profiles in the field, laboratory analysis, identifying soil-forming mineral through thin section method used a polarizing microscope. Based on mineral analysis results, the types of minerals identified as quartz, biotite, and k-feldspar are the primaries silicate minerals. The weathered mineral dominant was biotite, with a percentage ranged from 5-15%. The amount of k-feldspar mineral ranged from 5-15%, measuring 0.04-0.3 mm. The opaque is an oxide mineral, found in all profiles in the top and bottom layer, about 5-15%, with a size of 0.01-0.8 mm. Clay is the secondary minerals from alteration of primary minerals at 35-60%. The research results showed the potential of soil fertility in the Papalang areas classified as low criteria.

1. Introduction

The soil consists of four main components: mineral, organic, air, and water arranged in the space forming of the soil body [1]. Inorganic minerals in the soil originate from rock fragments and other primary minerals [2]. Sustainable soil fertility is supporting by the nutrient content in the mineral. According to [3], to determine the level of nutrient reserves of a soil type, it is necessary to analyze the soil's primary mineral composition. Knowing the amount of soil that contains weathered minerals means that the soil has a high nutrient reserve. The soil with dominant resistant minerals will make the soil insufficient of nutrient sources [4]. These soil properties are closely related to the dynamics of various nutrients in the soil. The type and amount of clay minerals significantly affect the soil's chemical characteristics, such as cation exchange capacity (CEC) and nutrient fixation [5].

The role of minerals in the soil is quite potential in agriculture because minerals derived from rocks contain various essential elements [4]. It can be used to maintain and increase land productivity and agricultural production. The different parent rocks have different mineral compositions and are important in soil formation [4, 6]. The soil formation process's speed depends on the grain size of the soil parent material. Easier it is to undergo the process of becoming soil [7].



Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

Based how important the role of soil minerals in assessing the potential soil fertility for plants, the search objective is to determine the physical properties of the soil and microscopically identified at the top layer (0-20 cm) and bottom layer (20 - 50 cm).

2. Research methods

The method used in research is a survey by observing and describing the profile in the Papalang areas and the results of laboratory analysis. The number of profiles in each landscape was determined used the catena sequence concept by making representative profiles based on the position on the slope (upper, middle, and lower slopes) [8-11].

There are two transect lines that used in the research areas. Each transect consists of three villages taken as the research areas, the number of observation profile points is six points. The research areas in the field are as follows: Transect 1 consists three villages: Bunde (S: 02° 21' 19,3"; E: 119° 11' 29,4"); Salukayu 3 (S: 02° 20' 50,5"; E: 119° 12' 59,5") and Kalonding (S: 02° 20' 27,3"; E: 119° 15' 32,8") then Transect 2 namely: Toabo (S: 02° 22' 26"; E: 119° 11' 38"); Salukayu 2 (S: 02° 22' 4,7"; E: 119° 12' 48,3") and Salukayu 4 (S: 02° 22' 31"; E: 119° 14' 12").

The observations and profile description, and soil sampling were carried out in Papalang areas, Mamuju Regency, South Sulawesi, Indonesia. Soil mineral analysis was held at the Petrographic Laboratory, Department of Geological Engineering, Faculty of Engineering, Hasanuddin University. The method used in the analysis of soil minerals is the thin section method.

The assessment criteria of potential soil fertility in research areas in Papalang refer to table 1.

Table 1. The Assessment criteria of potential soil fertility.

Weathered Minerals (%)	Criteria
100 - 70	Good
70 - 40	Moderate
40 - 0	Low

Source: [12]

3. Result and discussion

3.1 Soil forming minerals in transect 1

Commonly rock contains one or several minerals [13]. They will decompose into the parent material and form the soil perfectly, and then minerals contain in the stone also present in the parent material and the soil. Knowing about the mineral containing in the soil is the important indicator counting the amount of nutrients. Profiles 1, 2 and 3, as the common profiles found on transect 1, consisted from 3 villages: Bunde, Salukayu 3 and Kalonding.

Profile 1 (from Bunde village) based on microscopic observation in the top layer (0-20 cm), identified as brownish yellow color on ppl (plane polarize), brownish-grey on xpl (cross polarize). Sub-rounded grain shape, sub-angular mineral form, grain size 0.01-1.2 mm, mineral size 0.04-1.2 mm, inhomogeneous packing (presence of a solid part with granular particles and tenuous form pores) on other parts, and vugh pore type. The result microscopy of the bottom layer (20-50 cm), brownish-yellow on ppl, brownish-grey on xpl, brownish-yellow grain shape on ppl, brownish-grey on xpl, subrounded grain shape, subangular mineral form grain size 0.01- 0.6 mm, mineral size 0.07-0.6 mm, packing is not homogeneous; the presence of a part with granular particles and tenuous (forms a pore) in other parts, the vugh pore type. The microscopic performance of profile 1 (Bunde village) in transect 1 was shown in figure 1.

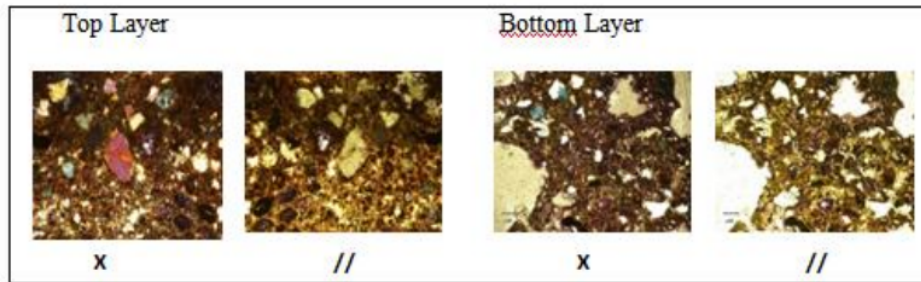


Figure 1. Microscopic performance of profile 1 (Bunde) in transect 1 (// = ppl, and x was xpl).

The microscopic observations on profile 2 (Salukayu 3 village) in the top layer (0-20 cm) were identified as brownish yellow color on ppl, brownish-grey on xpl, and, sub-angular mineral form, sub-rounded grain shape. Sub-angular mineral form, grain mineral size 0.01-1.4 mm, mineral size 0.04-1.4 mm. The packing not homogeneous, then the presence of a solid part with granular particles and tenuous (forming pores) in other parts, and channel pore type. The bottom layer of microscopy (20-50 cm) identified brownish yellow color on ppl, brownish-grey on xpl pad, sub-rounded grain shape, sub-angular mineral form, grain size 0.01-0.3 mm, mineral size 0.1-0.6 mm, packing not homogeneous; the presence of a part that is solid with granular particles and tenuous (forming pores) in the other parts, vugh pore type. The microscopic performance of profile 2 (Salukayu 3 village) in transect 1 was showed in figure 2.

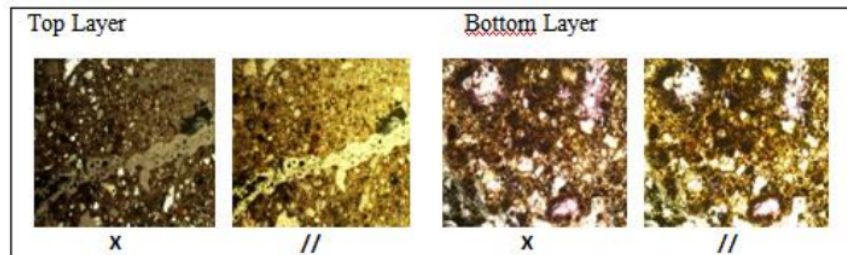


Figure 2. Microscopic performance of profile 2 (Salukayu 3) in transect 1 (//= ppl, and x was xpl).

The result of microscopic observation profile 3 (Kalonding village) on the top layer (0 - 20 cm), brownish-yellow color on ppl, brownish-grey on xpl, subrounded grain shape, subangular mineral form, grain size 0.01-0.9mm, mineral size 0.2-0. mm, packing is not homogeneous; the presence of a solid part with granular particles (forming pores) in other parts, vugh pore shape. The bottom layer of microscopy (20-50cm), brownish-yellow color on ppl, brownish-grey on xpl, sub-rounded grain shape, subangular mineral form, grain size 0.01-2.2mm, and mineral size 0.02-0.2mm. Non-homogeneous packing; the presence of a part that is solid with granular particles and tenuous (forming pores) in other parts, vugh pore type. The microscopic performance of profile 3 (Kalonding village) in transect 1 was shown in figure 3.

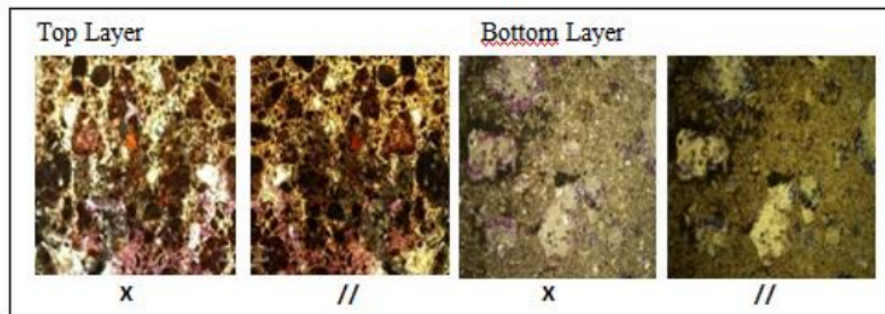


Figure 3. Microscopic performance of profile 3 (Kalonding 3) in transect 1 (//= ppl, and x was xpl).

Based on the results of mineral identification in soil samples on transect 1, the percentage of mineral content was shown in table 2. The results of the observation in table 2 showed that clay mineral as dominant with the percentage of 35, 45, and 60% compared to other minerals such as quartz 10%, biotite ranges from 10-15%, opaque 5-10%, muscovite 5-15% and K-Feldspar 5-15% for all profiles on transect 1. According to [14] the primary minerals such as quartz (SiO₂) resistant to weathering but are unable to provide nutrients. The soil in transect 1 can be assumed to have low fertility criteria.

Table 2. Percentage of mineral content in top and bottom layer at transect 1.

Mineral Types	Mineral contain on the layer (%)					
	Profile 1 (Bunde)		Profile 2 (Salukayu 3)		Profile 3 (Kalonding)	
	Top	Bottom	Top	Bottom	Top	Bottom
Quartz	10	10	15	10	10	10
Biotite	15	10	10	10	15	10
Opaque	10	10	5	5	5	5
Muscovite	15	15	-	5	5	10
K-Feldspar	5	10	5	5	-	5
Clay mineral	35	35	60	45	45	45

3.2. Soil forming minerals on transect 2

Profiles 4, 5, and 6 are profiles found on Transect 2, which consists of 3 villages, namely: Toabo, Salukayu 2 and Salukayu 4. The result of microscopic observations on Profile 4 (Toabo village), in the top layer (0-20cm), identified as brownish yellow color on ppl, brownish-gray on xpl, Subrounded grain shape, Subangular mineral form, Subrounded grain form, Sub-angular mineral forms, mineral grain size 0.01-1.1mm, mineral size 0.1-1.1mm. The packing is not homogeneous, the presence of a part that is dense with granular particles and tenuous (forming pores) in other parts, and vugh pore type. The bottom layer of microscopy result (20-50cm), brownish yellow color on ppl, brownish-gray on xpl, sub-rounded grain shape, sub-angular mineral form, grain size 0.01-0.3mm, and mineral size 0.1-0.3mm. Non-homogeneous packing; the presence of a part that is solid with granular particles and tenuous (forming pores) in other parts, vugh pore type (figure 4).

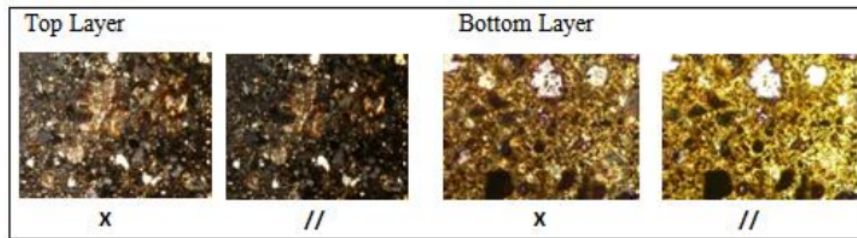


Figure 4. The microscopic performance of profile 4 (Toabo village) in transect 2 (//= ppl, and x was xpl).

The microscopic observations on profile 5 (Salukayu 2 village) in the top layer (0-20 cm), identified brownish yellow color on ppl, brownish-gray on xpl, subrounded grain shape, sub-angular mineral form, subrounded grain form, subangular mineral form, grain mineral size 0.01-0.9mm, mineral size 0.1-0.9mm. The packing is not homogeneous, the presence of a part that is dense with granular particles and tenuous (forming pores) in other parts, and vugh pore type. The microscopy of bottom layer (20-50cm) identified brownish-yellow color on ppl, brownish-gray on xpl pad, sub-rounded grain shape, sub-angular mineral form, grain size 0.01-1.2mm, mineral size 0.04-1.2mm, packing not homogeneous; the presence of a part that is solid with granular particles and tenuous (forming pores) in other parts, vugh pore type. The microscopic performance of profile 5 (Salukayu 2 village) in transect 2 was showed in figure 5.

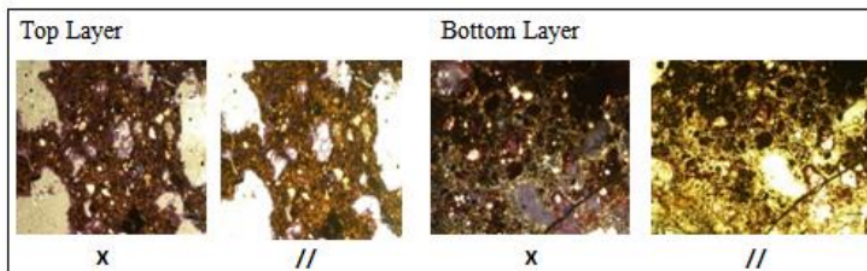


Figure 5. The Microscopic performance of profile 5 (Salukayu 2) in transect 2 (//= ppl, and x was xpl).

The microscopic observations on Profile 6 (Salukayu village 4) in the top layer (0-20cm), identified brownish-yellow on ppl, brownish-gray on xpl, sub-rounded grain shape, sub-angular mineral form, sub-rounded grain shape, Sub angular mineral form, mineral grain size 0.01-0.5mm, mineral size 0.1-0.5mm. Packing Not homogeneous, the presence of a solid part with granular particles and tenuous (forming pores) in other parts, and vugh pore type. The result of bottom layer microscopy (20-50cm) identified brownish-yellow color on ppl, brownish-gray on xpl pad, subrounded grain shape, sub-angular mineral form, grain size 0.01-0.9mm, mineral size 0.09-0.9mm, inhomogeneous packing; the presence of a part that is solid with granular particles and tenuous (forming pores) in other parts, vugh pore type (figure 6).

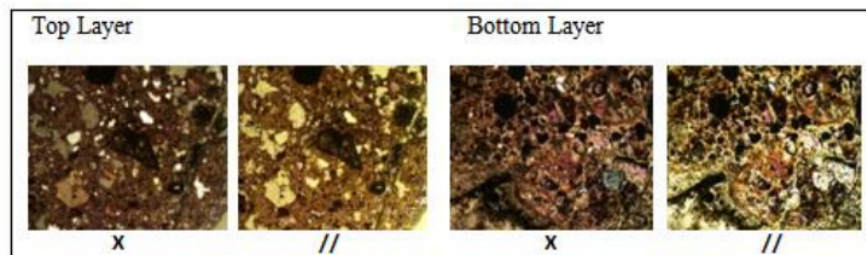


Figure 6. The Microscopic performance of profile 6 (Salukayu 4) in transect 2 (//= ppl, and x was xpl).

Based on the mineral identification results in soil samples on transect 1, the percentage of mineral content was shown in table 3.

Table 3. Percentage of mineral content in the top and the bottom layer at transect 2.

Mineral Types	The mineral content of the layer (%)					
	Profile 4 (Toabo)		Profile 5 (Salukayu 2)		Profile 6 (Salukayu 4)	
	Top	Bottom	Top	Bottom	Top	Bottom
Quartz	10	5	5	10	15	10
Biotite	10	10	5	10	10	5
Opaque	5	5	5	5	5	30
Muscovite	-	15	5	-	-	5
K-Feldspar	5	-	5	5	-	-
Clay mineral	55	55	55	47	50	45

Based on the mineral analysis results on six profiles at the research areas, the six types of minerals were identified: biotite, quartz, muscovite, K-Feldspar, opaque, and clay mineral. Quartz (SiO_2) as the primary silicate mineral. The structural framework is stable and resistant to weathering. Weathering speed is very slow. It consists of igneous rock 55% and sandstone 66%. They found in all profiles, both on the top and bottom layer. The amount of quartz found ranged from 5-15%, measuring 0.08-1.2mm. Biotite ($\text{K}(\text{Mg,Fe})_3(\text{Al,Fe})\text{Si}_3\text{O}_{10}(\text{OH,F})_2$) is a primary silicate mineral. The rate of weathering is very high. Nutrient content: K_2O (6 - 9%) and MgO (2-20%). Biotite was found in all profiles on transects at the top and bottom layers. The amount of Biotite minerals found ranged from 5-15%, measuring 0.05 mm - 0.6 mm. Muscovite ($\text{KAl}_2(\text{AlSi}_3\text{O}_8)\text{O}_{10}(\text{OH})_2$), is a primary silicate mineral. The rate of weathering is low/slow. Nutrient content; K_2O (8-11%) and MgO (0-3%). The amount of Muscovite mineral ranges from 5-5%, measuring 0.04-0.3mm. K-Feldspar (KAlSi_3O_8) is a primary silicate mineral. The weathering speed is low/slow. It contains K_2O nutrient (9-15%) and CaO (0%-3%). The amount of K-Feldspar mineral found ranged from 5-15%, measuring 0.04-0.3mm. Opaque, an oxide mineral, is found in all profiles in the upper and lower layers. Opaque minerals are found in about 5-15%, with a 0.01-0.8mm size. Clay minerals as the secondary minerals resulting from alteration of primary minerals, a found at most in the amount of 35-60%.

The high percentage of minerals in the bottom layer comes from the parent soil material, while the high percentage of minerals in the top layer comes from transporting the soil from a higher place. The potential mineral reserves in research areas were shown in table 4.

Table 4. The potential mineral reserves in research areas.

Transect	Profile/village	Non-weathered mineral (%)		Weathered mineral (%)		Criteria
		Top	Bottom	Top	Bottom	
I	1/ Bunde	40	45	15	10	low
I	2/Salukayu 3	25	25	10	10	low
I	3/Kalonding	20	30	15	10	low
II	4/Toabo	20	25	10	10	low
II	5/Salukayu 2	20	20	5	10	low
II	6/Salukayu 4	20	45	10	5	low

The potential nutrient content in the research areas was classified as low criteria that only sources from biotite minerals, namely: potassium and magnesium. The high content of clay showed that the soil is advanced in soil development. This nutrient content influences the cation exchange. The distribution of clay content at various depths indicated soil genesis processes such as the translocation of clay from the eluviation horizon to the illuviation horizon and the transformation of silt into the clay at that profile [16]. Therefore it deserves attention to manage the research area for agriculture cultivation.

13 Conclusions

Based on the results of observation, the conclusion of research: 1) minerals found in six profiles in the research areas, namely: biotite, quartz, muscovite, K-Feldspar, opa and clay minerals; 2) the nutrient content of the research areas were classified as low criteria, due to the high content of non-weathered minerals. The high percentage of minerals in the lower layer comes from the parent soil material, while the high percentage of minerals in the top layer comes from transporting the soil from a higher place. The soil of the research area has experienced intensive weathering and washing.

References

- [1] Weil R R and Brady N C 2016 *The Nature and Properties Of Soils* p 933
- [2] Bali I, Ahmad A and Lopulisa C 2018 Identifikasi mineral pembawa hara untuk menilai potensi kesuburan tanah *J. Ecosolum* **1** 81–100
- [3] Pramuji dan Bastaman M. 2009. Teknik analisis mineral tanah untuk menduga cadangan sumber hara. *Buletin Teknik Pertanian*, **14**(2) 80-82
- [4] Ahmad A, Lantera A and Jayadi M 2020 Analysis of nutrient-carrying minerals from Tempe Lake sediment *IOP Conf. Ser. Earth Environ. Sci.* **486** 1–6
- [5] Havlin J I, Beaton J D, Tisdale S M and Nelson W L 1999 *Soil Fertility and Fertilizers. An Introduction to Nutrient Management*. Prentice Hall, Upper Saddle River, New Jersey. p. 154-194
- [6] Irmak S, Surucu A K and Aydogdu I H 2007 Effect of different parent material on the mineral characteristics of soil in the Arid Region of Turkey. *Pakistan Journal of Biological Sciences*, **10**: 528-536
- [7] Haumahu J P 2009 Mineral pada tanah yang terbentuk dari batuan andesit dan bahan lepas di Desa Hative Besar. *Jurnal Budidaya Pertanian*, **5**(2) 74-80
- [8] Lee B D, Sears S K, Graham R C, Amrhein C and Vali H 2003 Secondary mineral genesis from chlorite and serpentine in an ultramafik soil toposequence. *Soil Sci. Soc. Am. J.*, **67**: 1309–1317
- [9] Pai C W, Wang M K and Chiu C Y 2007 Clay mineralogical characterization of a toposequence of perhumid subalpine forest soils in Northeastern Taiwan. *Geoderma*, **138**: 177–184

- [10] Garnier J, Quantin C, Guimarães E, Garg V K, Martins E S and Becquer T 2009 Understanding the genesis of ultramafic soils and catena dynamics in Niquelândia, Brazil. *Geoderma*, **151**: 204–214
- [11] Graham, R C and O'Geen A T 2010 Soil mineralogy trends in California Landscapes. *Geoderma*, **154**: 418–437
- [12] Notohadiprawiro T 1983 *Selidik Cepat Ciri Tanah di Lapangan*. Ghalia Indonesia. Yogyakarta
- [13] Warmana W dan Titisari A D 2004 *Agromineralogi (Mineralogi untuk Ilmu Pertanian)*. Universitas Gadjah Mada, Yogyakarta
- [14] Saptiningsih E 2007 Peningkatan produktivitas tanah pasir untuk pertumbuhan tanaman kedelai dengan inokulasi mikoriza dan *Rhizhobium*. *Bioma* **9**: 58
- [15] Djuhariningrum T dan Rusmadi 2004 *Penentuan Kalsit dan Dolomit Secara Kimia dalam Batu Gamping dari Madura*. Pusat Pengembangan Geologi Nuklir-Batan. ISBN. 978-979-99141-2-5
- [16] Suryani I 2014 Permeability various soil depth in forest land area conversion. *Jurnal Agrisistem*, **10**(1) 92-98

ORIGINALITY REPORT

12%

SIMILARITY INDEX

10%

INTERNET SOURCES

7%

PUBLICATIONS

9%

STUDENT PAPERS

PRIMARY SOURCES

1	pure.hw.ac.uk Internet Source	3%
2	Submitted to Universitas Hasanuddin Student Paper	2%
3	hal.sorbonne-universite.fr Internet Source	2%
4	library.donga.ac.kr Internet Source	1%
5	repository.unair.ac.id Internet Source	1%
6	Li, S.-H.. "Luminescence properties of biotite relevant to dating and dosimetry", Journal of Luminescence, 200611 Publication	<1%
7	journal.unhas.ac.id Internet Source	<1%
8	www.groundwatergovernance.org Internet Source	<1%

9	Submitted to Higher Education Commission Pakistan Student Paper	<1 %
10	Repositorioacademico.Upc.Edu.Pe Internet Source	<1 %
11	kipdf.com Internet Source	<1 %
12	d-nb.info Internet Source	<1 %
13	eprints.untirta.ac.id Internet Source	<1 %
14	iopscience.iop.org Internet Source	<1 %
15	www.thescipub.com Internet Source	<1 %
16	Submitted to Curtin University of Technology Student Paper	<1 %

Exclude quotes On

Exclude matches < 5 words

Exclude bibliography On