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UNCONVENTIONAL EXPLORATION TARGETS AND LATEST TECHNIQUES AND NEW TOOLS IN MINERAL AND COAL EXPLORATION

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proceedings

PROOCEDINGS OF UNCONVENTIONAL EXPLORATION TARGETS & LATEST TECHNIQUES AND NEW TOOLS IN MINERAL AND COAL EXPLORATION
MGEI 8th ANNUAL CONVENTION 2016

5-6 October 2016, Bandung, West Java, Indonesia
Masyarakat Geologi Ekonomi Indonesia (MGEI) – Ikatan Ahli Geologi Indonesia (IAGI)

PREFACE

It is with great pleasure that I welcome you on behalf of the Board of Masyarakat Geologi Ekonomi Indonesian Society of Economic Geologists (MGEI) to the eight Annual MGEI Convention in Bandung, which themed "Unconventional Exploration Targets & Latest Techniques and New Tools in Mineral and Coal Exploration", and present to you the proceedings of this event to share knowledge, experience, update the activities in exploration, development, technology including introduction to new concepts and ideas of metallic mineral and coal including UCG deposits.

This event is one of a series of annual events of MGEI. Series of this event consists of three sessions; pre-convention workshop, seminar and field trip to Krakatoa.

We believe that we have invited the best experts in the field where they will share their rich and extensive knowledge and experience with us; all that we believe will deliver and bring enormous benefits to the world of economic geology in Indonesia and the surrounding region

We warmly thank all authors and reviewers, and the editorial board for their invaluable contributions. We also thank our industry sponsors who made publication of the proceedings possible. We furthermore acknowledge and thank management of the companies who allowed sharing of knowledge of their projects. We are particularly grateful to the Organizing Committee whose hard work and dedication have played a major part in making this convention a success.

We look forward to meeting you again at the 9th MGEI conference in 2017!

Arif Zardi Dahlius

MGEI Chairman

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Seminar on MGEI 8th Annual Convention 2016
Aston Premiere Hotel, Bandung, West Java, October 4 – 6, 2016

Uranium Exploration in Sulawesi

I G. Sukadana[1], and H. Syaeful
Centre for Nuclear Mineral Technology, National Nuclear Energy Agency, INDONESIA.
e-mail: sukadana@batan.go.id

Abstract

Uranium exploration was conducted since 1978 covering almost all of Sulawesi Area including Banggai and Sula Islands. Granitic rocks and aluvial placer deposit was targeted as the source and host rock of radioactive minerals deposits in Sulawesi. Alkaline rock also became exploration target of radioactive minerals exploration recently. The methode that was applied in uranium exploration are combine the geological data, radioactivity measurement and geochemical analysis. Some area has high content of uraium, such as Masamba, Pasangkayu, Banggai, Sula, Barru and Mamuju. Uranium content in exploration area usualy not to high except in Mamuju. Uranium minerals can be occurs in rocks as its own minerals, as a substitute element in accessory minerals, adsorbed on Fe and Fe-Ti hydroxides-oxides and clay minerals adsorbed by organic matter, in crystal defects of major rock forming minerals, and dissolved in geologic fluids and fluid inclusions. Uranium also generally low concentrations (1 to several ppm), most of the uranium is substituted in the structure of one or several accessory minerals such as apatite, zircon, monazite, xenotime, and titanite, which represent refractory uranium sources for mobilization by most types of geologic fluids. Radioacive minerals was found in Sulawesi such as monazite, allanite, thorianite and titanite group (davidite). Exploration of uranium in Mamuju area is associaeted with rare earth elements (REE). Development of uranium minerals exploration was focused in Mamuju Area West Sulawesi.
Key words: Uranium, exploration, Granitic, Alkaline rocks, Sulawesi.

Introduction

Uranium exploration in Sulawesi has been conducted from 1978 to 1984 (Ngadenin et al. 2010). The activity was slow down in 1984 and begin in 2012 in Mamuju Area. Granitic rocks, acid volcanic rocks and aluvial deposits has been the target of uranium exploration. Uranium minerals naturaly can be formed in plutonic, metasomatic, hydrothermal, basinal diagenetic, metamorphic, and volcanic to sedimentary and superficial environments with the calcretes (Bruneton and Cuney 2016). The aim of the research are to define the distribution of the potential rocks and potential deposits in Sulawesi base on uranium exploration data.
Sulawesi can be divided into four (4) tectonic provinces namely (1) the Western and North Sulawesi Pluto-Volcanic Arc, (2) the Central Sulawesi Metamorphic Belt, (3) the East Sulawesi Ophiolite Belt and (4) the Banggai-Sula and Tukang Besi continental fragments (Maulana et al. 2013). Uranium exploration was conducted in all area except the East Sulawesi Ophiolite. The exploration step are various from early/previous study, general prospection and detailed prospection (Figure 1).

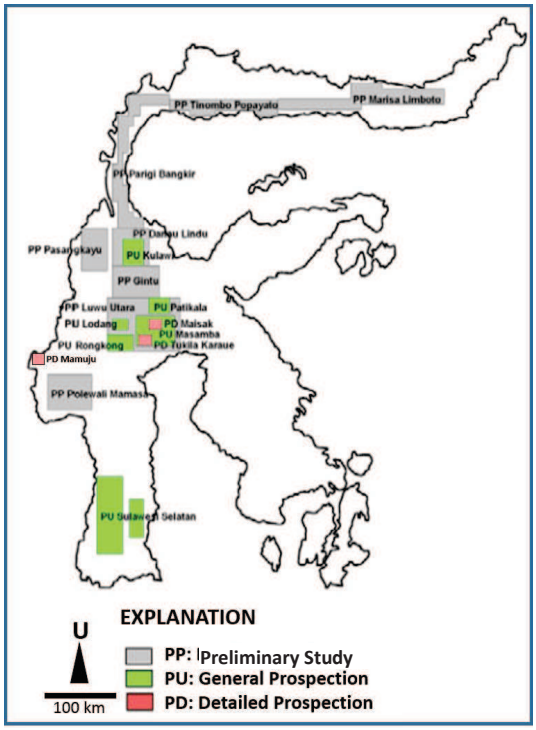

Figure 1: Exploration step and location in Sulawesi.

Preliminary study conducting by literature and previous report and general geology and tectonic setting of some area. The results of preliminary study will follow up by general prospection completed by geological information, regional data colection (geochemistry and rock sampling) also completed by radiometric mapping with regional scale. That methode will be resulting the radiometric map and uranium content from every sampel. The result of this step will be follow up by detailed prospection.
Geological setting is one of important aspect in the uranium exploration. Uranium distribution in the Earth's crust that commonly persisted through long periods of time, and through a combination of orogenic, metamorphic, and

sedimentary processes produced rocks with enriched uranium contents. The initial enriched uranium domain was successively remobilized and concentrated into new enrichments of one or more magnitudes above normal background forming uranium ore deposits(Bruneton and Cuney 2016). These process will be resulting the potential uranium deposits area.

Method and Data

Preliminary study, general and detailed prospection was conducted in several location in Sulawesi from the North to the South. Radiometric field measurement conducted by gamma suveyor SPP2NF to measure the intensity of gamma radiation and RS 125 to measure radiation dose rate, potasium (K), Thorium (Th) and Uranium (U) content. Laboratory analisis conducted in using UV-Vis Spectrometri.

Northwest area of Sulawesi covered Pasangkayu was conducted on a triple contact between metamorphic (Latimojong formation/Kls), granitic (Batuan Terobosan unit/Tmpi) and sedimentary rock (Lariang Formation/Tmpl). There are no potensial area of uranium anomaly in this area event there are posibility from lithology and stratigraphy aspect. Other location in Northwest of Sulawesi is Bangkir Area, Teluk Tambu, Teluk Dondo, Tanjung Tibo and Tindaki village has low content of anomaly with uranium content > 1 ppmU.

In Central Sulawesi, uranium exploration focused in Masamba Area. The exploration located on the north of Boni bay (Teluk Boni). The objective of this area are Tertiary Kabuno Granite (Tpkg) consist with granite, schists with pegmatitic. The result of this area has average of uranium content 5-20 ppmU. Some anomalies reach 100 ppmU and very consistent, with large area arround 300 m x 200 m. Kulawi Area is other exploration location in Central Sulawesi. The target of these area is granite and metamorphic formation along Kulawi river. Lithology of this area consist migmatite (Mg), Matamorphic (M), Intrusive granite (Td), volcanic material (Hga) and sedimentary Formation (Sd). The value of uranium content in the stream sediment have significan anomaly about 3 – 6 ppmU.

Banggai archipelago It comprises of four islands: Peleng, Banggai, Labobo and Bangkurung resting at a close distance from the eastern coast of Sulawesi. The target in this area mostly the Banggai granite and, as secondary objective, the sedimentary formations of the Bobang formation. The only anomalies detected, both geochemical and radiometric, coincide almost perfectly with the extension of the Banggai granite on these islands. Geochemical survey shows the very good correlation between the stream sediment results that are coinciding with the extension of the granite.

Sula Island exploration target has objective a variety of terrains, metamorphic, granitic and sedimentary. Radiometric results are very high readings on the Banggai granite with a background close to 200 c/s SPP2. Geochemical results: also carried on the same surface. Weak values on the sedimentary formations (0,5 ppmU – 0,7 ppmU). There are much higher values on the Bonggai granite (2 ppmU – 10 ppmU). The contact between granite and sedimentary rocks, outlined by the presence of a conglomerate has not been seen and is not located with radiometric or geochemistry measurements. Several result uranium exploration in Sulawesi are explain in Tabel 1 and the location in Figure 2.

Table 1. The sumary of Uranium exploration Result

No	Rock Type	Average (c/s) SPP 2NF	Anomaly (c/s) SPP 2NF	Anomaly Location
1	Late Tertiary Sediment, and part of Quartenary sea sediment	40	100	Pasangkayu, Polewali Mamasa
2	Midle – Late Tertiary Volcanic	100	300	Masamba Hulu, Polewali Mamasa Bantimala and Maros Gowa
3	Felsic – Intermediete Tertiary Intrution	125	300	Bangkir, Sabang and Masamba
4	Early Tertiary – Cretaceous Clastic Sediment	40	100	Masamba Hulu
5	Triassic Metamorphic	75	150	Masamba and Kulawi

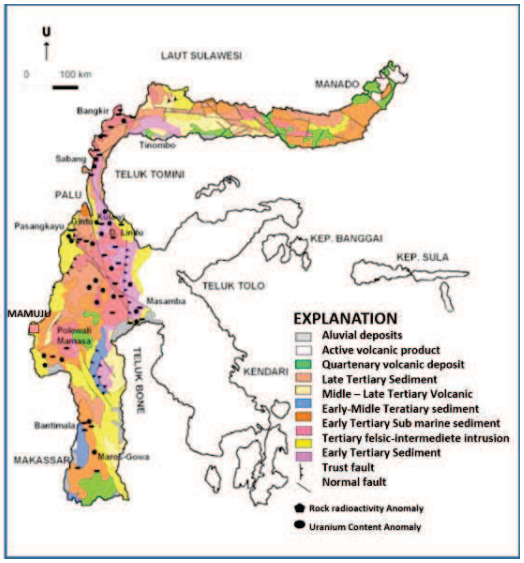

Figure 2: Geological map (Sukamto R., 1975) completed by anomaly of radioactivity and uranium content .

Recenly, starting from 2012, uranium exploration focused in Mamuju Area West Sulawesi. Mamuju has highest radiation dose rate in Indonesia (Iskandar, et al., 2014) The radiation value due to its Naturally Occurring Radioactive Material (NORM), has been identified in the area of Adang (Syaeful, et al., 2014). These volcanic rocks are composed of ponolite to dacite rock, with ultra-potassic affinity, formed in active continental margin (ACM)(Sukadana et al. 2015). Distribution of high radiation in this area are

controled by volcanic rocks distributions(Indrastomo et al. 2016).

The result of uranium and thorium analysis several sample from Mamuju has high content of uranium and thorium. The mineralization type of uranium mineralization is volcanic related of uranium deposit type. The result of UV-Vis analysis from several sampel in Mamuju as shown in Tabel 2.

Table 2. Geochemistry analysis result of several Mamuju sample.

No	Sample Code	U (ppm)	Th (ppm)
1	MJU/03	1104,0	216,8
2	MJU/06	1729,0	133,7
3	MJU/07	2291,1	209,7
4	MJU/09	1662,0	518,4
5	MJU/20	426,7	13.240,0
6	MJU/21	366,1	9919,0
7	MJU/30	224,4	163,7
8	MJU/45	1354,0	814,4
9	MJU/56	713,9	618,3
10	MJU/61	1113,0	212,5

The samples are from several area in Mamuju, such as Salunangka (Sample MJU 03), Botteng (Sample MJU 06, MJU 07, MJU 09), Hulu Mamuju (Sample MJU 20, MJU 21), Takandeang (Sample MJU 56, MJU 61), and Ahu (Sampel 30, MJU 45). The distribution of the sampling area are shown in Figure 3.

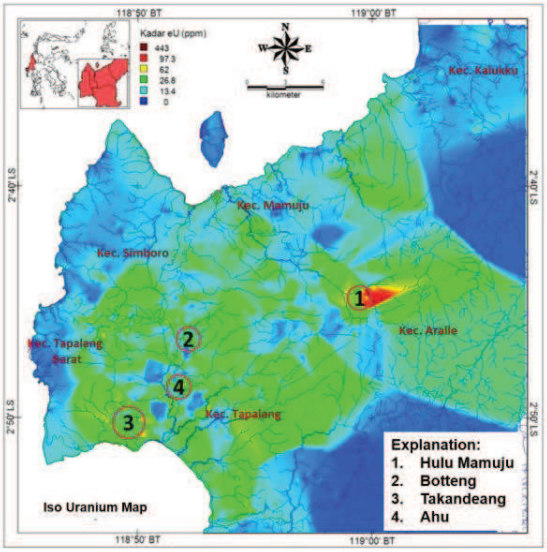

Figure 3: Iso Uranium Map as the result of RS 125 field measurement

Discussion

Early stage of exploration in Sulawesi, was focused in granitic rocks and its related sedimentary and metamorphic rocks. Uranium deposits resulting solely from magmatic processes such as partial melting or fractional crystallization are rare, in most cases, uranium is initially mobilized from igneous rocks by hydrothermal and/or surficial fluid(Ballouard et al. 2017). Anomalous of uranium content and rock radioactivity found in Triassic metamorphic rocks group, late Cretaceous to early Tertiary clastic sedimentary rocks group, Tertiary acid to intermediate intrusive rocks, middle to late Tertiary volcanic rocks and late Tertiary sedimentary rocks. These distribution of uranium are related to the series of granitic Ilmenite series rock type in Sulawesi. The granitic rocks in the northern part belong to magnetite-series whereas those in the southern part generally belong to ilmenite-series. Its explained by assimilation process between magma and crustal material that containing a various quantity of reduced C-and S-bearing sediments (Maulana et al. 2013). These two magmatic series are considered to represent different redox condition, source rock composition, and crystallization and emplacement history These are mostly I-type, with the CAK series also including a late phase S-type (Maulana et al. 2016). The granitic rock that has high content of uranium are S-Type granite.

The result of recently uranium exploration in Mamuju, West Sulawesi was changed the mindset of uranium exploration in Indonesia. Usualy the target of uranium exploration was felsic plutonic and volcanic rocks. The formation of Adang volcanic composed by feldspathoid lava rock, pyroclastic, tuffities with intermediete to basaltic composition (Sukadana, et al. 2015). These volcanic products are representative of orogenic magmas emplaced in a subduction context, with metasomatized mantle sources conforming to those of converging continental margin basalts (Conte et al. 2016). Edifice of volcanics rock, the morphology, characteristics and petrochemical composition of volcanic outcrops recognized in the submarine portions allowed to enlarge the knowledge on the development of the volcanic activity in the area(Romagnoli et al. 2013). The increase of uranium elements in volcanics rock are corelated to the increase of K_2O(Burwash and Cavell 1978).

The uranium exploration in Mamuju Area was shown the impact of alkalinity of rocks with the content of uranium. This model can adobe to develop of uranium exploration methode in the future.

Conclusion

Uranium exploration in Sulawesi was conducted since 1978 – 1984 with the object of uranium exploration area are granitic, metamorphic and its related sedimentary rocks. Recently uranium exploration was expans to alkaline volcanic rocks such as in Mamuju Area. The significant content of uranium was found in Adang volcanic rock in several places in Mamuju, West Sulawesi.

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