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Uncovering the Golden Potential: Exploring Alluvial Gold Deposits in Kebakalan Village

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Abstract:- Kebumen is a region that is very interesting geologically due to the diversity of rocks with varying ages of formations and environments. Kebakalan Village, which is one of the areas in Karanggayam- Kebumen, has the Luk Ulo River connected to the Karanggayam-Sadang sediments. This river is a location that has alluvial gold deposits. Research on the composition of alluvial gold can be done using various analytical techniques, one of which is X-ray Fluorescence (XRF) analysis. The purpose of this study was to perform XRF analysis on samples collected from alluvial deposits in Kebakalan to determine the elemental composition of gold oxide compounds. The method used was laboratory testing at the Integrated Testing and Research Laboratory of Gadjah Mada University using an ED-XRF instrument made by Rigaku with the NEX-QC + QuantEZ model. The test results produced low-Z, medium-Z, and high-Z spectrum graphs, resulting in quantitative results where the highest percentage was found in quartz at 39.20%. This indicates that there is a gold content (Au) in the sample.

Keywords:- *Oxide Compund, Gold (Au), Alluvial, ED- XRF, Spectrum.*

I. INTRODUCTION

Kebumen is an area that is geologically very interesting because of the diversity of rocks with varying ages of formations and environments. Gold deposits in the South Gombong Karst area around Mount Arjuno, Mount Gadung, and Mount Poleng are as mineralization sociated with quartz veins. Alteration and development of mineralizsulfate a low sulfate epithermal form in the super chalcedonic zone. In general, mineralization in South Gombong occurs in a shallow position with a temperature of around 100°C, and a low pH close to acid due to the influence of meteoric air (Ansori & Puswanto, 2011). The systems of change and mineralization that develop in this area are low sulfate epithermal shallows close to the Earth's surface, including the super chalcedonic zone, which is located around the groundwater table transition boundary but above the boiling zone. In the north, indications were found around Karanggayam-Sadang District in the Melange Complex area. This indicates that the area has qualified mineral deposits in the form of primary deposits.

The processes of erosion, transport, and sedimentation that occur in the disintegration of primary gold deposits produce alluvial deposits (Suprapto, 2007). Alluvial deposits can form large resource sources when the surface body of the eroded ore is a wide dispersion source. These deposits can be the result of dispersion from primary gold deposits or the result of the redeposition of older deposits. As a result of this process, the grains in this gold deposit tend to be larger than the grains in the primary deposit (Suprapto, 2007; Boyle, 1979). The distribution of these gold deposits generally occupies river basins. Kebakalan Village has the Luk Ulo River which is connected to the Karanggayam-Sadang sediments. However, there has been no further research in this area.

The elemental composition of alluvial gold deposits plays an essential role in understanding the origin, distribution, and quality of the gold deposits. Various analytical techniques have been used to determine the elemental composition of alluvial gold, including X-ray Fluorescence (XRF) analysis. XRF is a non-destructive analytical technique used to identify and determine the concentration of elements present in solid, powder, or liquid samples (Sari, 2016). XRF can analyze a wide range of elements, including gold, and is widely used in the mineral exploration and mining industry. This test can measure elements from beryllium (Be) to Uranium at the level of trace elements (multielement) (Sari, 2016; Jamaluddin & Umar, 2018), even below the ppm level. The analytical method with the X-ray Fluorescence Spectrometer (XRF) is the most used method because the sample preparation procedure is simple, the analysis time is relatively fast, and the stability of the machine is good (Jamaluddin & Umar, 2018; Yamasaki, 2014), the results are accurate and quite economical (Omatola & Onojah, 2009), the analysis is fast and the results the analysis is qualitative and quantitative (Jamaluddin & Umar, 2018).

In this study, we performed XRF analysis on samples collected from alluvial deposits in Kebakalan to determine the elemental composition of gold oxide compounds. Our objective was to understand the mineralogy and geochemistry of the deposit, as well as to evaluate the potential for gold mining and processing. This study is relevant to the objective mining industry, as it provides valuable information for the management of gold resources in Kebakalan. The findings of this study can also contribute to the understanding of the geological processes involved in the formation of alluvial

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gold deposits and can inform future research on the topic. Overall, this study presents an important contribution to the knowledge of alluvial gold deposits in Kebakalan and provides insights into the mineralogy and geochemistry of the deposit using XRF analysis.

II. RESEACRH METHODE

Alluvial sediment samples will be collected from various locations in Kebakalan Village, Karanggayam, Kebumen, Central Java, Indonesia. The sampling sites will be chosen based on the presence of visible gold particles and the proximity to known gold-bearing areas. The samples will be collected using a hand shovel and placed in individual plastic bags to avoid cross-contamination. Cross-contamination of samples refers to the unintentional transfer of material from one sample to another during processing, which can lead to inaccurate or misleading results (Hodgson et al, 2020; Joana et al, 2021; Fievet et al, 2019; Stepens et al, 2018). This is a significant concern in various fields, including pathology, microbiology, and molecular biology. To prevent cross-contamination, researchers must take appropriate precautions, such as using separate equipment and workspaces for different samples, wearing protective gear, and following strict protocols for handling and processing samples (Hodgson et al, 2020; Fievet et al, 2019; Abatenh et al, 2018).

The process described in the question is a common method for preparing sediment samples for analysis. The collected sediment samples will be air-dried and sieved to obtain a particle size fraction of -100 mesh (150µm) (Figure 1). The sieved samples will be homogenized thoroughly to ensure that the sample is representative of the site (Tiut & Wait, 2020; Olga & Andrei, 2022). This is an important step in preparing sediment samples for geochemical analysis (Balaram & Subramanyam, 2022). The sample can be either in powder or liquid form. If the sample is in powder form, a minimum of 2 grams of sample is required, whereas if the sample is in liquid form, a minimum of 2 mL of sample is required.

Fig 1 Sample (a) Sand of Alluvial Gold in Kebakalan, and (b) Samples with a Particle Size Fraction of -100 Mesh in a Plastic Bag.

Equipment for this XRF Test is sample cup sets (cup, ring, and lid), a stainless spatula, a thin film, and a press tool (Solazzi, 1984) (Figure 2). The sample cups can be used for powdered solid, liquid, and solid sample retention (Solazzi, 1984), and the thin film is used for analyzing liquids (Moriyama & Morikawa, 2017). The press tool is used to compress the sample into the sample cup. The stainless spatula is likely used for transferring the sample into the cup (Solazzi, 1984). Energy-dispersive X-ray fluorescence (ED-XRF) is an analytical technique used to determine the elemental composition of a sample. Qualitative analysis using ED-XRF can be done through two methods: fundamental parameter (FP) and standardless (Raja & Andrew, 2023). An ED-XRF spectrometer consists of an X-ray source, a sample holder, and a detector (Adams, 2005 & 2019; Streli et al, 2017; Potts & Tsuji, 2019). The technique offers the rapid, non-destructive analysis of test materials presented as solids, powders, particulates collected on filter substrates, and liquids. XRF measurements made with field-portable devices are most often used for qualitative analysis (Anonim, 2023).

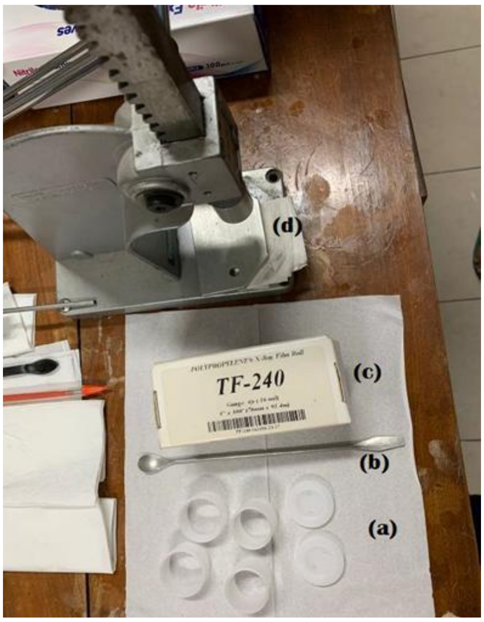

Fig 2 Equipment for XRF Test; (a) Sample Cup Sets, (b) a Stainless Spatula, (c) a Thin Film, and (d) a Press Tool.

The FP method is a first-principles calculation method of chemical element concentration from the measured XRF spectra using the fundamental parameters (FPs) such as the X-ray absorption coefficients, fluorescence yields, jump ratios, branching ratios, and the incident spectrum from the X-ray tube (Kawai et al, 2019). The theoretical calculations require prior knowledge of the sample's elemental composition and its physical properties (Kawai et al, 2019).

The FP method allows the calculation of X-ray intensities theoretically and is used in various aspects of X-ray fluorescence (XRF) quantitative analysis (Kataoka et al, 2020). These parameters include the excitation and detection efficiency, attenuation of the X-ray beam, and the sample matrix's effect. The theoretical calculations require prior knowledge of the sample's elemental composition and its

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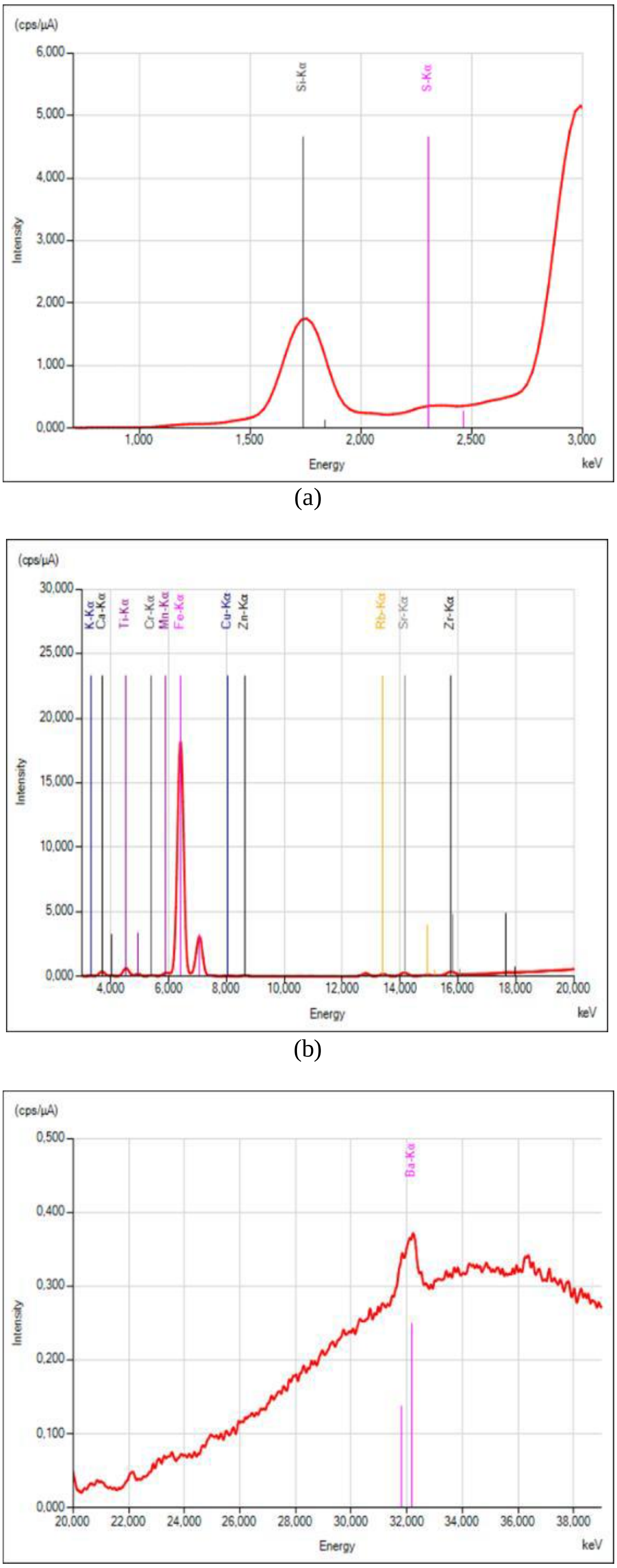
physical properties. The standardless method is a technique used in quantitative X-ray spectroscopy that does not require prior knowledge of the sample's elemental composition. Instead, it uses mathematical algorithms to calculate the elemental concentrations based on the measured intensities of the X-rays emitted from the sample. This method requires the use of a fundamental parameters model and an empirical algorithm to calculate the elemental concentrations (Newbury, 1998). Standardless analysis has been used in various studies, including the quantification of phase compositions in powder samples (Shaltout et al, 2012). The accuracy of this method can be assessed by measuring and quantifying standard samples at different accelerating voltages and input count rates (Pinard et al, 2020).

This research was conducted at the Integrated Testing and Research Laboratory of Gadjah Mada University using an ED-XRF instrument made by Rigaku with the NEX-QC + QuantEZ model. This study was conducted with measurement conditions (Table 1) and procedures (Figure 3). Then, the analysis was performed by selecting Spectrum Display and analyzing the peaks of the detected elements. To obtain the relative percentage composition of the elements, the Data processing tab was clicked, followed by selecting Quant calculation. The sample was re-measured (at least 5 times) for the detected elements from the screening results and analyzed to obtain the composition values (in relative %).

III. RESULT

The ED-XRF analysis of the alluvial river sand sample in terms of oxide compounds revealed the presence of various oxides, including SiO2, SO3, K2O, CaO, TiO2, Cr2O3, MnO, Fe2O3, CuO, ZnO, Rb2O, SrO, ZrO2, and BaO. The characteristic peaks of these oxides were observed in the spectrum display, confirming their presence in the sample. Further analysis using quant calculation revealed the relative percentage composition of these oxide compounds in the sample. These results provide valuable information on the composition of oxide compounds in the alluvial river sand sample, which can be used for further analysis and characterization.

One important consideration when interpreting XRF results is the sensitivity of the technique. XRF is generally not very sensitive to light elements, such as hydrogen, helium, and lithium, and may not be able to detect them at all. However, it is quite sensitive to heavier elements, such as those in the middle and bottom rows of the periodic table. XRF can also be used to determine the relative amounts of different elements present in the sample. The ED-XRF spectra refer to the intensity plots of X-rays emitted by a sample when it is irradiated with high-energy X-rays. These spectra can be divided into three main categories based on the energy range of the detected X-rays: Low-Z spectrum, Medium-Z spectrum, and High-Z spectrum (Streli et al, 2017; Wulandari et al, 2022).



(a)

(b)

(c)

Fig 3 Test Results Graph: (a) Low-Z Spectrum, (b) Medium-Z Spectrum, and (c) High-Z Spectrum.

Table 1 Qualitative Test Results of Alluvial River Sand Samples using ED-XRF Method (Fundamental Parameter/ Standardless)

Component	**Result**	**Standar Dev.**	**Unit**
SiO_2	39,30	0,25	Mass%
SO_3	0,292	0,01	Mass%
K_2O	1,884	0,037	Mass%
CaO	7,167	0,069	Mass%
TiO_2	6,668	0,042	Mass%
Cr_2O_3	0,347	0,009	Mass%
MnO	0,725	0,019	Mass%
Fe_2O_3	43,17	0,22	Mass%
CuO	0,105	0,004	Mass%
ZnO	0,102	0,002	Mass%
Rb_2O	322	11	mg/kg
SrO	686	13	mg/kg
ZrO_2	664	40	mg/kg
BaO	753	46	mg/kg

The Low-Z spectrum refers to X-rays that have low energies and are emitted by elements with low atomic numbers (Z). This spectrum is typically used to detect elements such as carbon, nitrogen, oxygen, and fluorine.

The Medium-Z spectrum refers to X-rays that have medium energies and are emitted by elements with medium atomic numbers (Z). This spectrum is typically used to detect elements such as sodium, magnesium, aluminum, and silicon. The High-Z spectrum refers to X-rays that have high energies and are emitted by elements with high atomic numbers (Z). This spectrum is typically used to detect elements such as sulfur, chlorine, potassium, calcium, and iron. This is a graph of the test results in the form of low-Z, medium-Z, and high-Z spectra shown in Figure 3, which are then evaluated by comparing the peaks with a standard XRF spectrum database to determine the presence and concentration of the elements in the sample being tested. It should be noted that XRF results typically need to be interpreted in conjunction with other analytical results to obtain more complete and accurate information about the sample, in order to obtain quantitative results of the contained oxide compounds (Table 2).

Based on Table 2, the results of the ED-XRF analysis indicate that the sample contains 39.20% SiO2 (quartz), 0.292% SO3, 1.884% K2O, 7.167% CaO, 6.668% TiO2, 0.347% Cr2O3, 0.725% MnO, 43.17% Fe2O3, 0.105% CuO, 0.102% ZnO, 322 mg/kg Rb2O, 686 mg/kg SrO, 664 mg/kg ZrO2, and 753 mg/kg BaO. The test results show that quartz has the highest percentage. This is because quartz is the most abundant mineral in the Earth's crust (Kilian et al, 2018) and is also one of the common accessory minerals found in gold deposits (Ernawati et al, 2017). Gold minerals cannot be seen macroscopically, but through mineralogical observation, the presence of gold in the form of electrum minerals is detected. The amount of electrum minerals found is very small, with a creamy white appearance and a very fine size of up to 5µm. It is randomly dispersed and included in quartz (Aminah 2018). Some common oxide com-pounds found in alluvial gold ore deposits include iron oxides (FeO and Fe2O3), silicon ox-ides (SiO2), calcium oxides (CaO), and titanium oxides (TiO2) (McKibben, 2005; Bulatovic, 2010; Bartin, 2014; Natarajan, 2018). The chemical composition of gold grains in alluvial deposits can also provide information on the deposit type and mechanism of ore deposition (Nono et al, 2021). According Nursanto, et. Al (2022), The AAS test results indicate that the sample contains approximately 11 g/ton of Au (Table 2) (Nursanto et al, 2022).

Table 3 Results of Au Content Analysis using AAS (Nursanto et al, 2022)

Code	**Original Sample**	**Au (gr/ton)**
A-1	Sand	11,32
A-2	Sand	11,85
A-3	Sand	11,62

IV. CONCLUSION

In this study, the mineral potential contained in the sand sample, such as the Au content using XRF, showed that quartz (SiO2) had the highest percentage at 39.20% compared to other minerals. This indicates that there is a possibility of finding gold (Au) in the alluvial deposits of the Luk Ulo river, located in Kebakalan village.

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