# Application of Prompt Gamma-ray Activation Analysis to Copper-based Coins

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## 1. Introduction

The study of the composition and contents of the elements of coinage provides important information concerning technology, provenance and other facts. Such as history, culture, economy, and so on. Recently, composition analysis of the various coinages has researched various fields of study. This paper is intended as an investigation of study for coinages composition analysis by using a Prompt gamma ray activation analysis (PGAA). PGAA is recognized as a very powerful and unique nuclear method in terms of its non-destruction, high precision, and no time-consuming advantages. This method is used for the analysis of trace elements in various types of sample matrix such as metallurgical, environmental, biological samples, etc. It follows from what has been show that the present the possibility of the PGAA will contribute in many study.

## 2. Methods and Results

For this study, coin samples were prepared such as different kinds of coins divided into seven. KOR-A is Korean ten-won old coins made in 2005s, KOR-B is Korean ten-won old coin made in 2007s, KOR-C is Korean ten-won new coins made in end of the 2006s, JAP-A and JAP-B is Japanese coin 5en coins, JAP-C is Japanese 10en coins made in heisei8, JAP-D is Japanese 10en coins made in heisei18. And these samples analyzed in a SNU-KAERI PGAA facility at the HANARO research reactor. The preparing coins irradiated for several hours in the PGAA facility. Irradiation time was optimized by pre-adjustments. The spectrum file from KOR-A measured during 6000seconds, KOR-B measured during 10000seconds, KOR-C measured during 2134seconds, JAP-A measured during 30000seconds, JAP-B measured during 10000seconds, JAP-C measured during 10000seconds, KOR-D measured during 12000seconds,

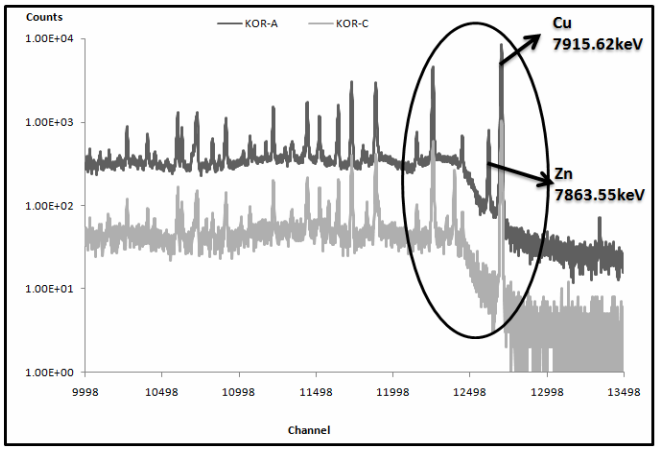


Figure 1. Prompt gamma-ray spectrum from a Korean coins. (KOR-A counting time is 6000sec. KOR-C counting time is 2134sec)

Table 1.

| | Element | Energy [keV] | Net area | unc. | Efficiency | Atomic mass[u] |
|---|---|---|---|---|---|---|
| **KOR-A** | Cu | 7915.62 | 88320 | 334 | 5.154E-05 | 63.546 |
| | Zn | 7863.55 | 7430 | 158 | 5.217E-05 | 65.39 |
| **KOR-A** | Cu | 7915.62 | 158014 | 549 | 5.154E-05 | 63.546 |
| | Zn | 7863.55 | 13041 | 253 | 5.217E-05 | 65.39 |
| **KOR-A** | Cu | 7915.62 | 10439 | 129 | 5.154E-05 | 63.546 |
| | Al | 1778.92 | 29578 | 224 | 2.505E-04 | 26.982 |
| **JAP-A** | Cu | 7915.62 | 265447 | 620 | 5.154E-05 | 63.546 |
| | Zn | 7863.55 | 24250 | 350 | 5.217E-05 | 65.39 |
| **JAP-A** | Cu | 7915.62 | 142247 | 452 | 5.154E-05 | 63.546 |
| | Zn | 7863.55 | 13627 | 237 | 5.217E-05 | 65.39 |
| **JAP-A** | Cu | 7915.62 | 227422 | 581 | 5.154E-05 | 63.546 |
| | Zn | 7863.55 | 1254 | 258 | 5.217E-05 | 65.39 |
| **JAP-A** | Cu | 7915.62 | 169563 | 498 | 5.154E-05 | 63.546 |
| | Zn | 7863.55 | 1376 | 182 | 5.217E-05 | 65.39 |

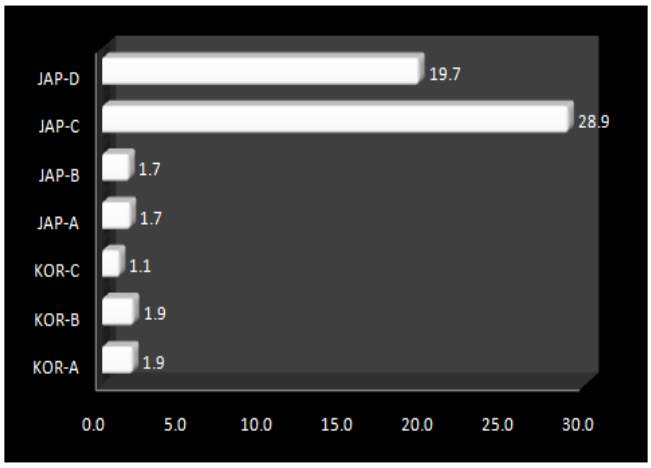


Figure 2. Prompt gamma-ray spectrum from a Korean coins.

The partial spectrum around peak of, which shows that

Figure 4 shows the raw data and the background-reduced lines.

Figure 4(a) show the

Figure 4(b) and 4(c) shows those for

Table 1 shows a PGAA experiment factor defined as

## 3. Conclusions

In this study, the elements and composition analysis of Korean and Japanese coins procedure using the PGAA. This procedure will be applied to the peak search and identification in the complex prompt gamma-ray spectrum.

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