



**NNAMIBIA UNIVERSITY  
OF SCIENCE AND TECHNOLOGY**

**DEPARTMENT OF CIVIL, MINING AND PROCESS ENGINEERING**

<b>QUALIFICATION: BACHELOR OF ENGINEERING IN MINING ENGINEERING</b>	
<b>QUALIFICATION CODE: 08BMENG</b>	<b>LEVEL: 7</b>
<b>COURSE CODE: GSS721S</b>	<b>COURSE NAME: GEOSTATISTICS</b>
<b>SESSION: JUNE 2023</b>	<b>PAPER: THEORY</b>
<b>DURATION: 3 HOURS</b>	<b>MARKS: 100</b>

<b>FIRST OPPORTUNITY EXAMINATION</b>	
<b>EXAMINER(S)</b>	<b>Prof Benjamin MAPANI</b>
<b>MODERATOR:</b>	<b>Prof. Mallikarjun PILLALAMARRY</b>

**ANSWER QUESTION ONE (1) (40 marks) AND ANY OTHER THREE (3) (20 marks each)**

**Formulas**

- Statistical Variance:  $\sigma^2 = \sum (X_i - \mu)^2 / n$
- Where n is the number of data points in the given set, and  $\mu$  is the mean.
- Geostatistical Variance:  $\sigma^2 = \sum (X_i - X_{i+h})^2 / n$ 
  - Where n is the number of pairs
  - The standard deviation (SD) is the square root of the variance.

1. The following layout of boreholes has been drilled in an area of Platinum Group Metals (PGM) mineralization.

1.1 Calculate the grade at point T (Figure 1) using a spherical semi-variogram model with a nugget effect of  $0.2 \text{ (g/t)}^2$ , a partial sill of  $1.5 \text{ (g/t)}^2$  and  $a = 175 \text{ m}$  as shown in Figure 2 [18]

1.2 Comment on the weights assigned to the four samples [6]

1.3 Can sample M be used with the other four samples to calculate the grade at point T? Why? Will the estimation error (kriging variance) increase or decrease if sample M is used? Why? [2,2, 2]

1.4 Distinguish between a geostatistical and a statistical variance. Explain which of the two is appropriate for ore deposit mining. [5]

1.5. Briefly explain the advantages and disadvantages of grade capping in gold deposits. [5]

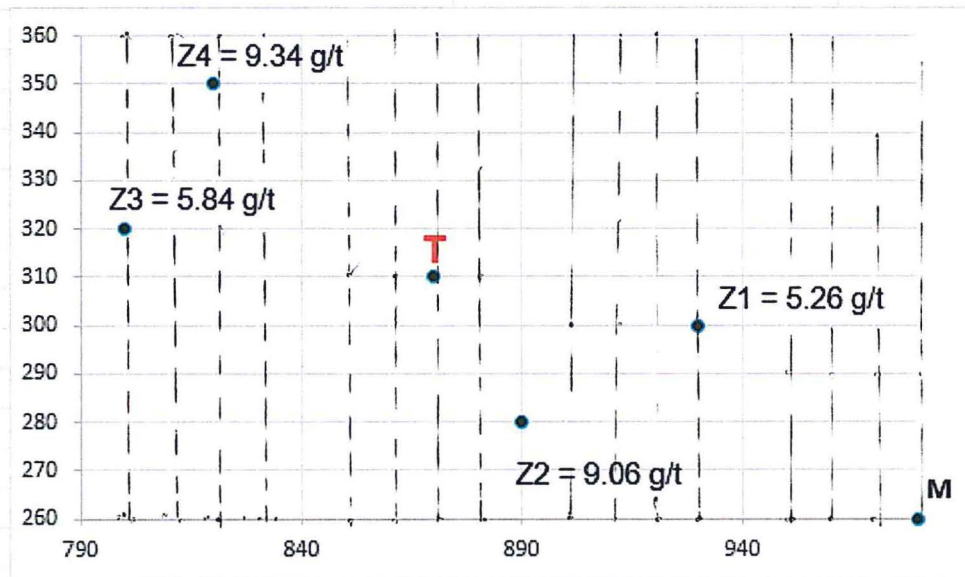


Figure 1: Borehole layout

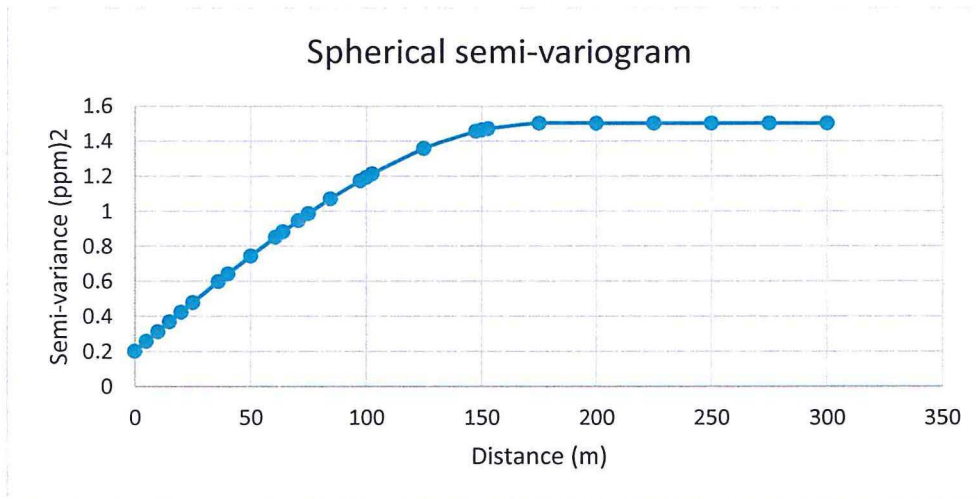


Figure 2: Spherical semi-variogram of Platinum Group Metals mineralization.

2. Answer the following as briefly and succinctly as possible:
  - 2.1 Why is Geostatistics a preferred resource estimation method over statistical methods? [4]
  - 2.2 Describe what is meant by information effect and support effect in resource estimation [4, 4]
  - 2.3 Mention typical features of a semi-variogram, what information do they provide? [8]
  
3. (a) Mention 3 causes of noisy semi-variograms [6]
  
- (b) Why is it that both geostatistical and statistical method will give the same grade estimate if a deposit has a nugget effect equivalent to a total sill of 2.5 (see Figure 3 below). [8]
- (c) What is nugget effect and how can it be overcome in a mining scenario? [6]

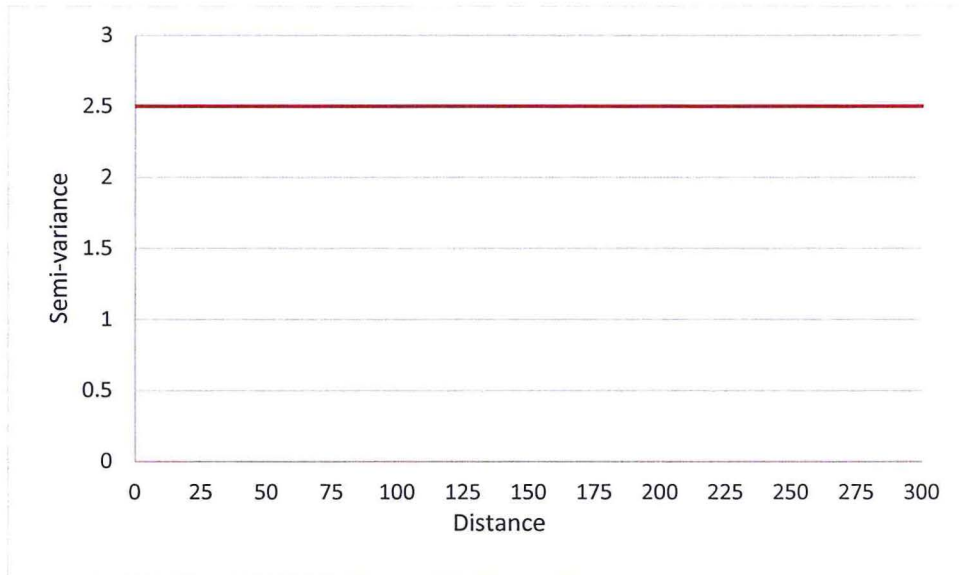


Figure 3.

4. Differentiate between isotropy and anisotropy. Give two types of anisotropy and how are they different from each other. [20]
5. (a) Distinguish between quantitative and qualitative evaluation of exploration and mining projects. [10]
- (b) In mining it is usually observed that the data available to make decisions is not sufficient for ordinary statistical methods. What approaches are taken by Mining and Exploration companies to improve and make this data to be acceptable to the Stock Exchanges and Banking Firms to allow them access funding? [10]