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Analysis of drainage pattern and its relationship with gold potential in Batu Melintang, Jeli, Kelantan

M S Sulaiman[1,*], W S Udin[1], M A Khan[1], N Sulaiman[1] R Ismail[1] and A Bahar[1]

[1]Faculty of Earth Science, Universiti Malaysia Kelantan, 17600 Jeli, Malaysia
*Corresponding author: syakir.s@umk.edu.my

Abstract. The study is conducted within approximately 42km^2 in the northern Kelantan, specifically at Batu Melintang, Jeli. The study aims to analyze drainage and its relationship with gold potential. The lithology of the study area consists of metasedimentary, metamorphic and igneous rock. Sungai Pergau and Sungai Tadoh are the main rivers fed by tributary drainages located in the highly potential gold zones. It is important to understand the relationship of the potential gold zones with the drainage system because if any exploitation of the drainage system occurs, it could disrupt the main river system. This research was conducted using the geological gridded sampling method followed by the fire assay method to detect gold. Drainage analysis is conducted using satellite imagery and ArcGIS software. The result shows that Grid 1, 2 and 3 show the highest gold potential, whereas grid 7, 8 and 9 show the lowest gold potential. The drainage analysis shows the majority of the drainage pattern is trellis type and only grid 2 with rectangular and grid 9 with dendritic type. The study also found that the lowest drainage coverage (8052m) is in grid 2, which has the highest gold intensity. In contrast, the highest drainage coverage (15032m) is in grid 9, with the lowest gold potential.

1. Introduction

Kelantan comprises four types of rocks; i) sedimentary and metasedimentary rock, ii) granitic rock, iii) volcanic rock, and iv) unconsolidated sediment. The regional geology of Kelantan can be divided into three zones; i) a central zone of sedimentary, ii) metasedimentary rocks bordered on the west and iii) an east-west zone by granites of the Main Range and Boundary Range, respectively as shown in Figure 1. The granitic rocks located at the eastern part of Kelantan act as boundary range, and intrusive felsic granite at the southwest and western parts of Kelantan act as the main range of the area's mountainous region. The Silurian-Ordovician metasediment such as schists, phyllite and slates enclosed the main range granite in the southwest. The Triassic sediment, including shale, siltstone and limestone located at the central region of Kelantan and unconsolidated Quaternary sediment, occupies the northern part of Kelantan. [1]

Batu Melintang is a well-known high potential gold deposit zone due to its location within the Bentong-Raub suture zone. It is located in northern Kelantan, specifically in the Jeli district. Figure 2 shows the location of the research area. It is considered as a highly potential alluvium placer deposit as the traditional miners are panning along Sungai Pergau and abandoned mines detected. Goh et al. [2] identified Batu Melintang as part of the gold zone or gold-silver-mercury zone based on the low sulphide quartz veins present in the area. This low sulphide quartz vein is found to form along the shear zones of granitoid bodies in the Batu Melintang area [2]. According to Ariffin [3], most of the gold is mined from two types of deposits: quartz lode and stockwork deposits related to the accretionary prism along the terrain boundary of the Raub-Bentong Suture.

As stated by Summerfield [4] and Morisawa [5], drainage patterns can be classified based on structural controls. The dendritic pattern is having a lack of structural control and rock/sediment of uniform resistance. The parallel pattern is closely spaced faults with steep topography and non-cohesive (erodible) sediments. Volcanic cones or domes can create a radial pattern. The trellis pattern is caused by tilted or folded alternately resistant/weak sedimentary units. Joints or faults cause the rectangular pattern. The annular pattern is eroded dome in alternate resistant/weak sediments. Calderas, craters, tectonic basins create the centripetal pattern. The deranged pattern is produced by glaciated or highly disturbed terrain.

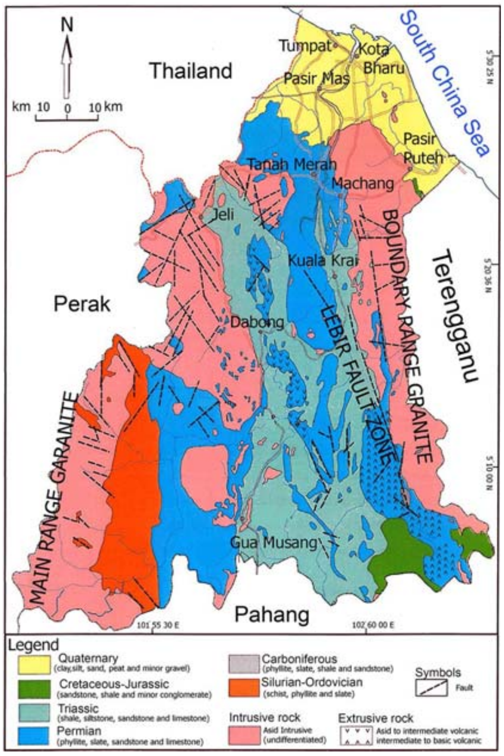

Figure 1. Geological Map of Kelantan [1]

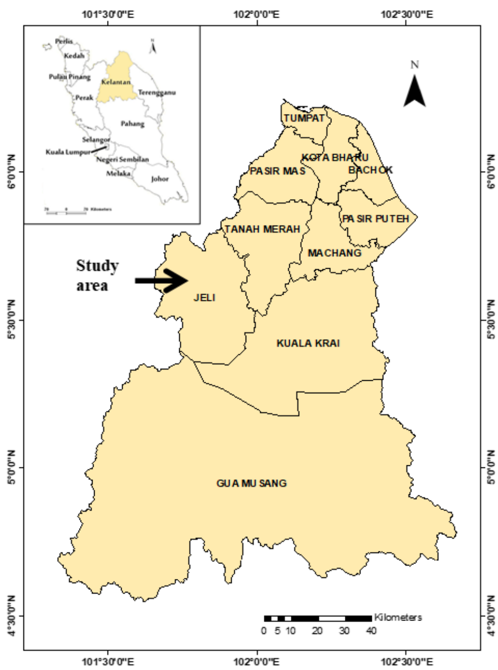

Figure 2. Map of Jeli District in Kelantan.

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2. Material and Methods

By conducting gridded geological mapping, data were taken, and sampling was done. 72 rock samples were obtained through the inventory method of 9 grids in the study area. The samples were prepared and crushed into a powder tested for their gold intensity using the geochemical method. The methods used are conventional methods for gold detection used for geochemical analysis: Fire Assay with Atomic Absorption Spectrometry finish (FA-AAS) method. The FA-AAS method to determine gold is precise, economical, and comparatively simple [6]. AAS determines the gold concentrations by using the wavelengths of light absorbs by the gold. The detection limit for this method is 0.01 ppm for lower detection and 1000 ppm for upper detection limit. Then the average gold intensity map was produced. According to the previous study [7], drainage pattern analysis was done using satellite images and GIS. The drainage analysis in this study was conducted by observing the drainage pattern measuring the drainage by using satellite imagery. Drainages were digitized based on high-resolution imagery using Google Earth Pro and ArcGIS software. Then, the length of drainage (drainage coverage) in each defined grids were measured, and types of drainage pattern were determined.

3. Results and Discussion

The average gold intensities map shows that gold's high potential occurs in the northern part of the study area, especially in grids 1, 2 and 3. The value of the gold intensity for those grids are ranging from 0.25-0.45ppm. Average gold intensities for grids 4, 5 and 6 range from 0.05-0.06ppm. The least potential grids are 7, 8, and 9 with only the intensity of gold <0.01-0.02ppm, as shown in Figure 3. The highest gold intensity can be found in grid 2, which is around 0.45 ppm, whereas the lowest one can be found in grid 9, which is lower than 0.01ppm.

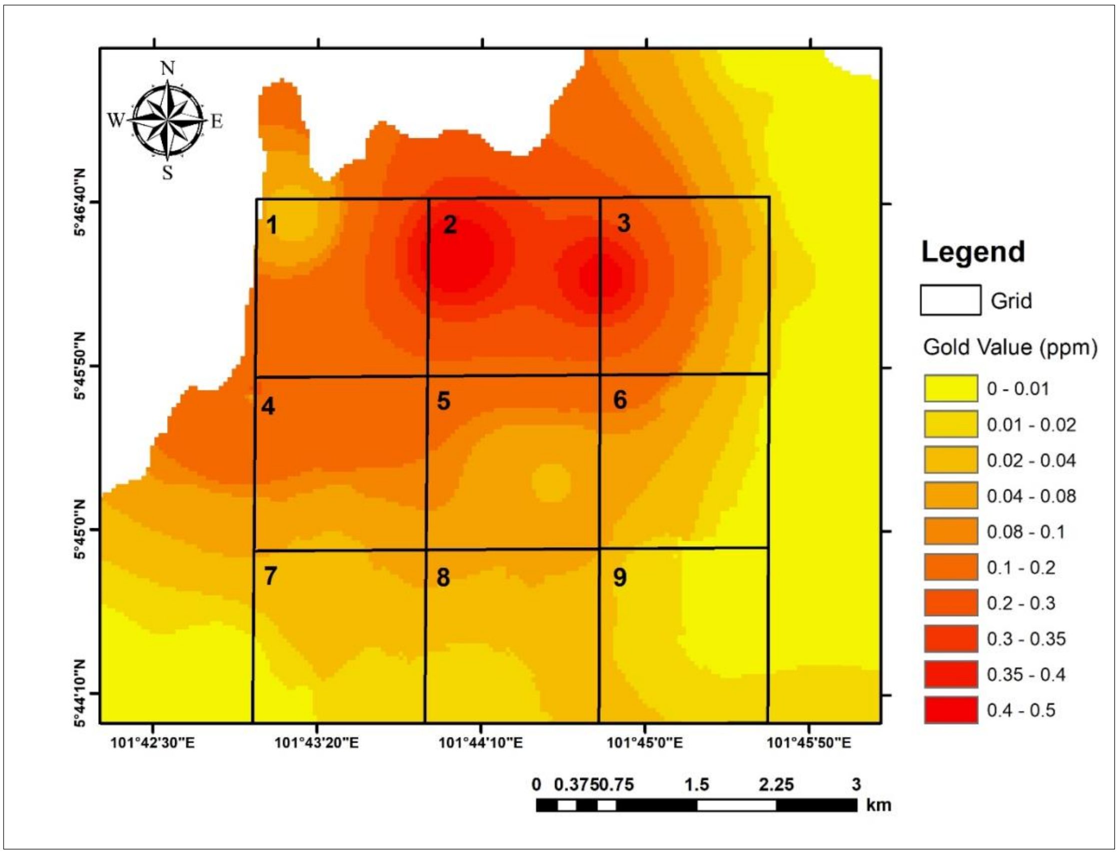

Figure 3. Gold Value map.

The analysis showed that three types of drainage patterns existed in the study area, trellis, rectangular, and dendritic, as shown in Figure 4. The grids 1, 3, 4, 5, 6, 7, and 8 showed the dominant types of river patterns are trellis and sub trellis. However, all those girds are considered trellis due to the dominant trellis patterns within the grids. Grid 2 shown a semi-rectangular pattern but can be assumed as rectangular as the pattern includes major river bending rectangular. Grid 9 shown dendritic pattern drainage. Drainage length or drainage coverage ranging from 8052m up to 15032m. Trellis patterns involve drainage coverage ranging from 9550-13364m. The dendritic pattern shows the highest drainage coverage within grid 9, whereas the rectangular pattern shows the lowest drainage length, which can be found in grid 2. Dendritic patterns, which are by far the least common, develop in areas where the rock (or unconsolidated material) beneath the stream has no particular fabric or structure and can be eroded equally easily in all directions. Examples would be granite, gneiss, volcanic rock, and sedimentary rock that has not been folded. Trellis drainage patterns typically develop where sedimentary rocks have been folded or tilted and then eroded to varying degrees depending on their strength. Rectangular patterns develop in areas with very little topography and structural control of bedding planes, fractures, or faults that form a rectangular network.

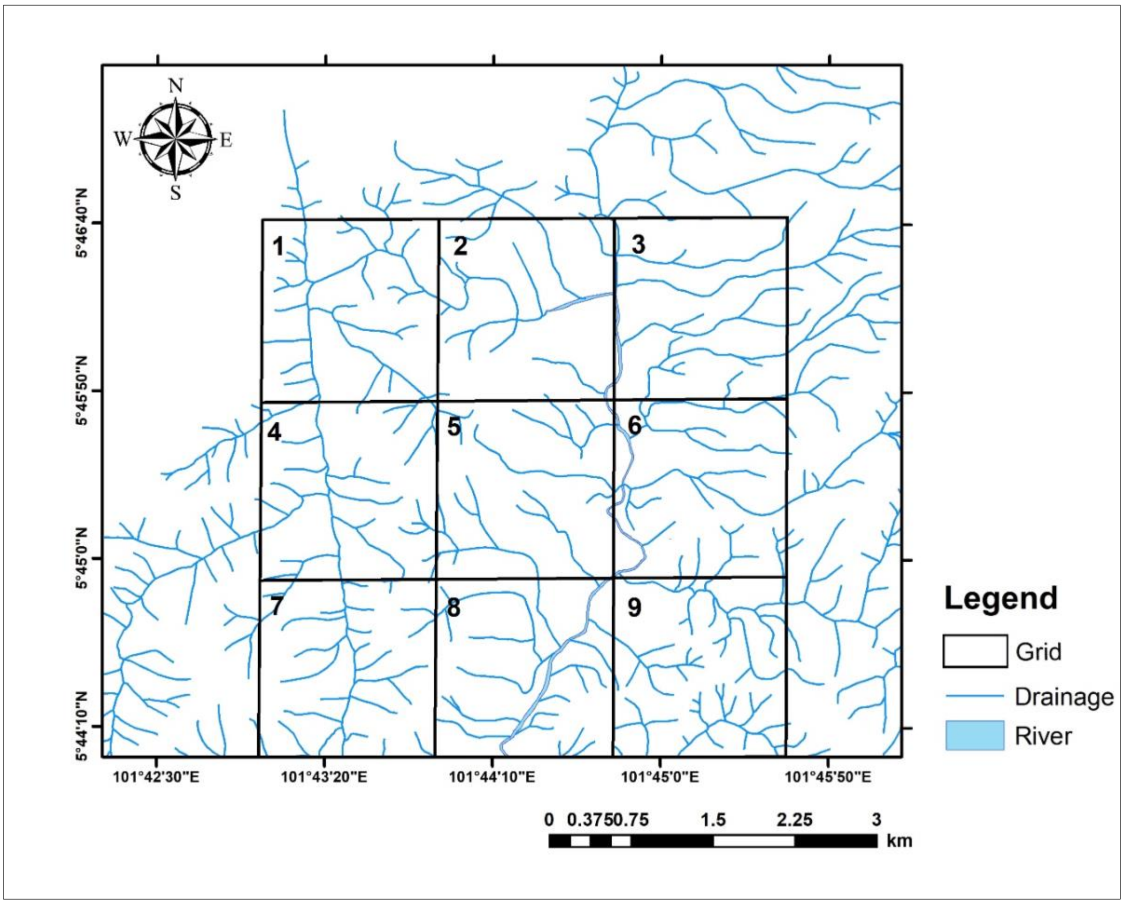

Figure 4. Drainage map

The analysis also showed a correlation between drainage pattern types with the drainage coverage and the average gold intensities in the particular grid, such as in grid 2 and grid 9. The highest gold intensity of 0.45ppm occurred with the lowest drainage coverage of 8052m in the grid with the rectangular pattern. The lowest gold intensity <0.01ppm in grid 9 occurred with the highest drainage coverage of 15032m in the grid with the dendritic pattern. Table 1 summarises the dominant drainage type, drainage coverage and average gold intensities in the research area. Figure 5 shown the combined map of gold intensities and drainage of the grids.

Table 1. Dominant drainage type, drainage coverage and average gold intensities in the research area.

	Grid 1	Grid 2	Grid 3	Grid 4	Grid 5	Grid 6	Grid 7	Grid 8	Grid 9
Dominant drainage type	Trellis	Rectangular	Trellis	Trellis	Trellis	Trellis	Trellis	Trellis	Dendritic
Drainage coverage(m)	11199	8052	10158	11288	9550	12188	13364	12035	15032
Average Gold intensities(ppm)	0.25	0.45	0.35	0.06	0.04	0.05	0.01	0.02	<0.01

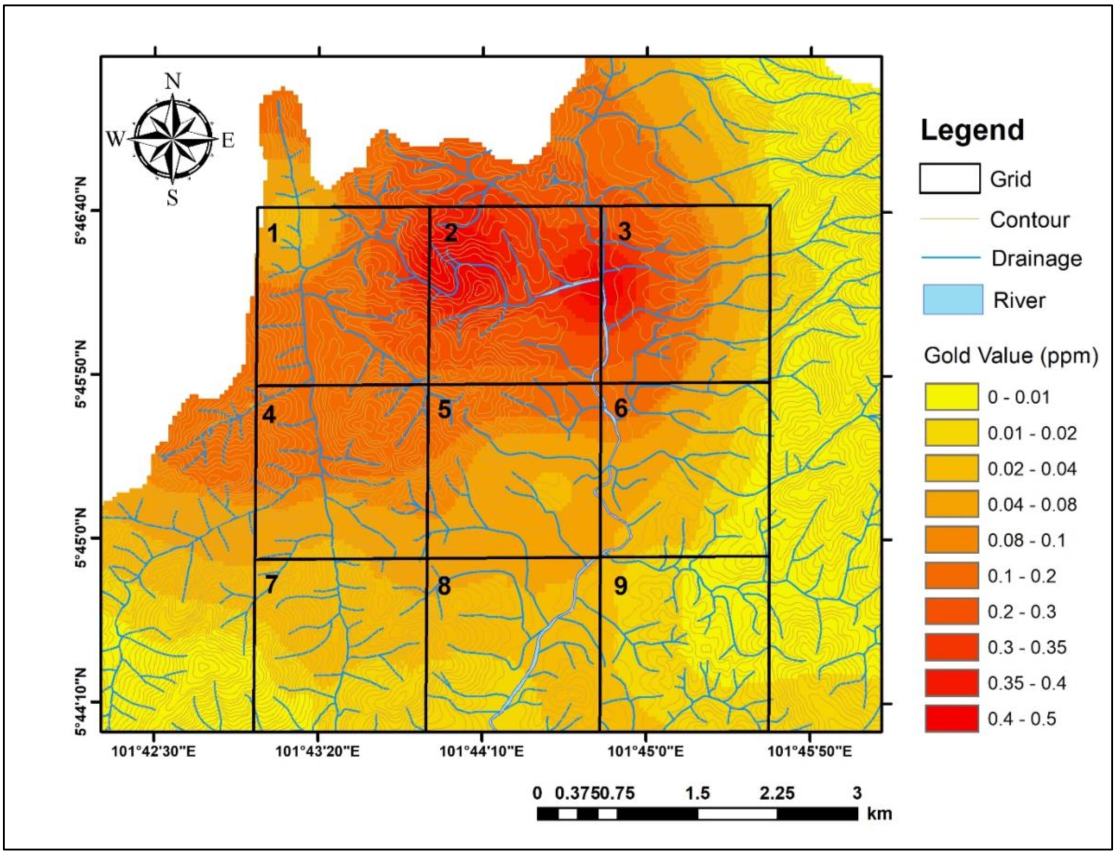

Figure 5. Combined map of gold intensities and drainage pattern.

4. Conclusion

The study's findings show that the drainage pattern is correlated with the gold intensities in the structurally controlled zone, such as in the shear suture zone. The rectangular drainage pattern has the lowest drainage coverage. However, it shows the highest gold potential compared to the dendritic pattern with the highest drainage coverage but shows the lowest gold potential.

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