Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2019, 6(6):159-164**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Modeling of Magnetic Anomaly Map of Kütahya-Emet (Turkey) Mine Site using Cellular Neural Network Method

A. Muhittin Albora

Istanbul University-Cerrahpaşa, Engineering Faculty, Geophysical Department, Avcılar, Istanbul, Turkey
Email: muhittin@istanbul.edu.tr

Abstract In this study, Cellular Neural Network (CNN) algorithm was applied to Geophysical Engineering and the magnetic anomaly map of Kütahya Emet Değirmisaz Mine site was interpreted. As it is known that CNN method is able to make the difference between residual and geographic distinction, the map obtained from the application of CNN method to the magnetic anomaly map of the region is compared with the results obtained by drilling information and other methods and successful results have been obtained.

Keywords Cellular Neural Network (CNN), Mine Site, Kütahya-Emet, Magnetic Anomaly

Introduction

The development of industry in this century depends on the mining sector. Iron ore is one of the most widely used mines on earth. The inner core of our world consists of solid iron and nickel while the core of the tooth consists of molten iron and nickel. While iron is a compound in nature, it is the raw material of steel which is important in industry. The major iron minerals in nature are magnetite (Fe_3O_4), hematite (Fe_2O_3), limonite ($2Fe_2O_3$. $2H_2O$), goethite (Fe_2O_3. H2O) and siderite ($FeCO_3$). Iron ore constitutes 95% of the metals produced in the world [1]. Turkey has a very important area in terms of iron ore. In this study, the magnetic anomaly map obtained by Mineral Research and Exploration (MTA) located in Çatak, Emet district of Kütahya region is discussed. The magnetic anomaly map was firstly applied to the CNN algorithm and the boundaries of the mines were determined. The CNN method was used as a distinction and limit detection method which is an important feature in gravity and magnetic data. The most important feature of the CNN method is that it takes into account neighborly relations. Chua and Yang (1988) first proposed CNN. CNN was applied to various Geophysical studies and successful results were obtained [2-8]. In this study, magnetic anomaly map of Kütahya Emet Değirmisaz Mine Site was used.

Cellular Neural Networks

Cellular neural networks are mostly composed of cells arranged in order to form a two-dimensional array. In contrast to known artificial neural networks, each cell is in close contact with cells in its immediate neighborhood (Figure-1). The basic function of the CNN method in image processing is to convert any input image into an output image according to the intended purpose. Here, when the output image is taken into account in the first form of the CNN method, each pixel value is limited to -1 and +1. However, the input images can have multiple gray levels after having the appropriate voltage values. After any transient initiated or driven by an input image, the CNN-treated image always converges to a steady-state fixed point if it meets the required conditions. In image processing, the CNN method is generally a non-linear and dynamic processing of a given input image to generate the output image.

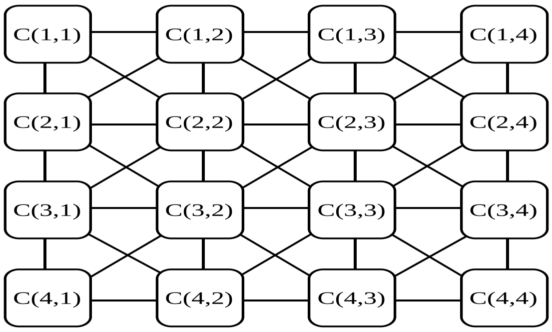

Figure 1: Two-dimensional (4x4) cellular neural network [9]

Each cell in these structures:

a) A linear input unit with a weighted aggregation

b) Linear dynamic interface

c) n It is a dynamic circuit consisting of an output unit (Piece-Wise Linear: PWL) according to the segmented (generally three-part) origin (Figure-2)

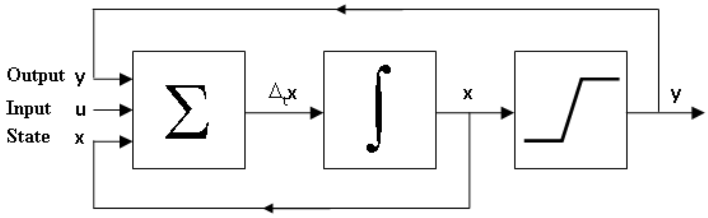

Figure 2: Block diagram of an artificial neural network [10].

The r-neighborhood of a cell in the Cellular Neural Network (CNN) is defined as follows.

$$N_r(i,j) = \{C(k,l) | \max(|i-k|, |j-l| \le r, \quad 1 \le i \le M; 1 \le j \le N \} \tag{1}$$

Here,

(i, j) : The index vector, which determines the location of the cells in the array,

$C(i, j)$: i.line, j. is the parameter that represents the location of the cell in the column.

Differential equations that characterize the cellular neural network can be written as follows:

$$\frac{dx_{i,j}(t)}{dt} = -S \cdot x_{i,j}(t) + \sum_{(k,l)\in N(i,j)} A_{i,j;k,l} \cdot y_{k,l}(t) + \sum_{(k,l)\in N(i,j)} B_{i,j;k,l} \cdot u_{k,l}(t) + I_{i,j} \tag{2}$$

$$y_{i,j}(t) = f[x_{i,j}(t)] = \frac{1}{2} \cdot (|x_{i,j}(t)+1| - |x_{i,j}(t)-1|) \tag{3}$$

where

$A_{i,j}$: feedback linkage coefficients

$B_{i,j}$: Input connection weight coefficients

I : The threshold level, which is usually the same for each cell

S : feedback weight coefficient is defined as.

The equation that characterizes the discrete time Cellular Neural Network is expressed as follows.

$$x_{i,j}(n+1) = \sum_{(k,l)\in N(i,j)} A_{i,j;k,l} \cdot y_{k,l}(n) + \sum_{(k,l)\in N(i,j)} B_{i,j;k,l} \cdot u_{k,l}(n) + I_{i,j} \tag{4}$$

$$y_{i,j}(n) = f[x_{i,j}(n)] = \frac{1}{2} \cdot (|x_{i,j}(n)+1| - |x_{i,j}(n)-1|) \tag{5}$$

In this equation, in addition to classical filtering, iterative filtering from feedback link weight coefficients A is also made.

Here, the inputs of the cells are real numbers with values in the range $u_{i,j}$, [-1,1]. The outputs $y_{i,j}$ of the cells are the outputs that can only have çıkış1 or +1 values if the stability conditions are reached at the end of a certain period (or cycle).

One of the most important features that distinguish CNN from artificial neural networks is that the feedback (A) and input (B) connection weight coefficients form a constant connection network on the studied plane (Space Invariance Property) (Figure-3).

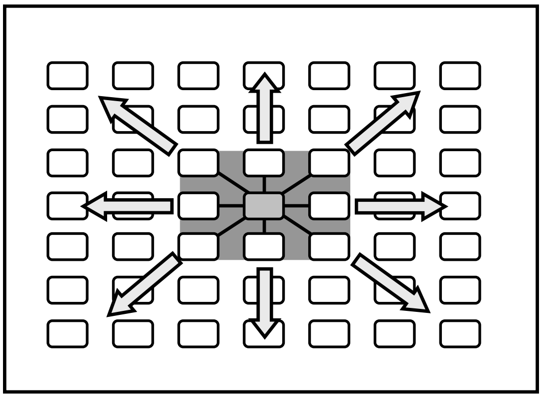

Figure 3: Invariance in plane [10].

$$A(i,j;k,l) = A(k-i,l-j) \qquad B(i,j;k,l) = B(k-i,l-j) \tag{6}$$

Application of Method

In this study, Kütahya region was chosen as the application area (Figure 4). Kütahya is dominated by the Central Anatolian climate in terms of temperature, while the Marmara climate is more dominant in terms of rainfall regimes. Kütahya, BC It is a place where many civilizations and cultures were founded in 3000 years. The first settlers who settled in ancient times are the Phrygians. Kütahya was later a Roman, Byzantine, Germiyanoğulları, Ottoman city. Kütahya and its surroundings are known as the city of princes in the Ottoman Empire. In the study, magnetic anomaly map on iron field in Kütahya Emet Değirmisaz region was used. In mineral exploration work, it is necessary to reveal the places where the mine is located by using filter methods. After this process, the location and depth of the mine are tried to be found by drilling to the regions where the anomalies are dense. Image processing techniques used in electronic engineering have been used in recent years to solve geophysical problems. Figure 5a shows the map of the magnetic anomaly map as a relief and contour. In Figure 5b, the relief and contour map obtained after applying CNN to this map is shown on top of each other. When the output of the CNN map is examined, it is seen that the mining site is clearly revealed. This shows that the CNN method provides successful results in both border detection and regional and residual anomaly maps. Soundings were made in places with strong anomalies in the magnetic anomaly map (Figure 6). In the CNN map output, A-A1, B-B1, C-C1 sections were taken from the places where the anomalies were strong and their geological structures were shown under sections (Figure 7).

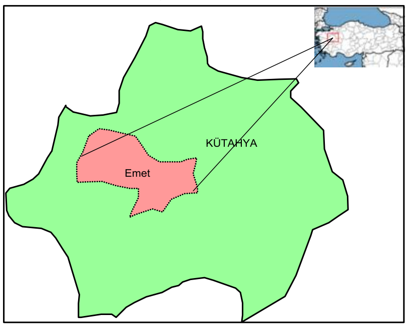

Figure 4: Location of the work area

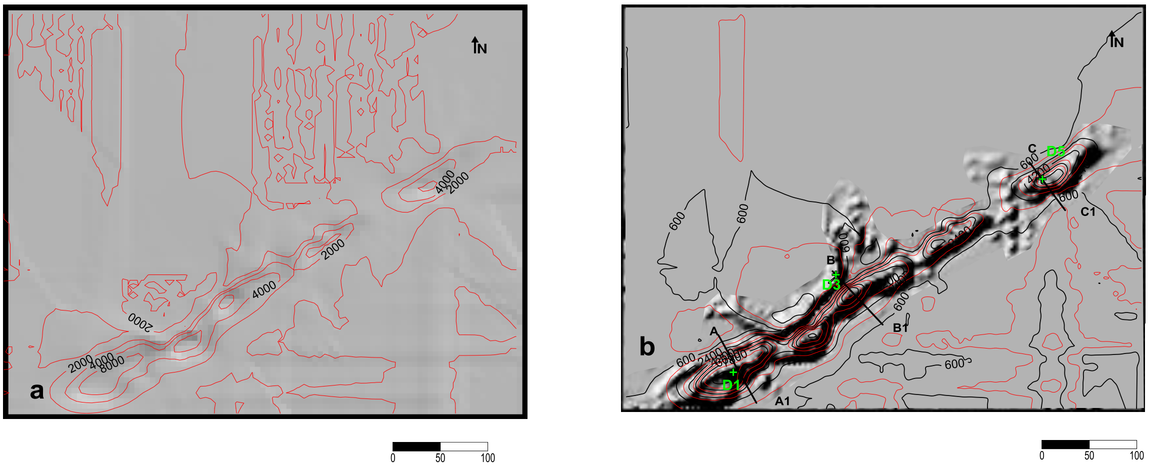

Figure 5: Magnetic anomaly map of iron mine area in Emet region of Kütahya a) relief image b) Relief image of CNN output (D1, D2, D3 drillings made, A-A1, B-B1, C-C1 shows the locations of the sections taken).

Geology of the Region

n the northwest of the Menderes Massif, the Miocene basins generally have a NE-SW extension. The regional folds, paleogeography, control this extension and fracture lines of the underlying rocky intermediate. The extension of the Pliocene basins is NW-SE. Salihli Alaşehir, Gediz-Simav basins with all the characters still have a graben property that continues to develop [12].

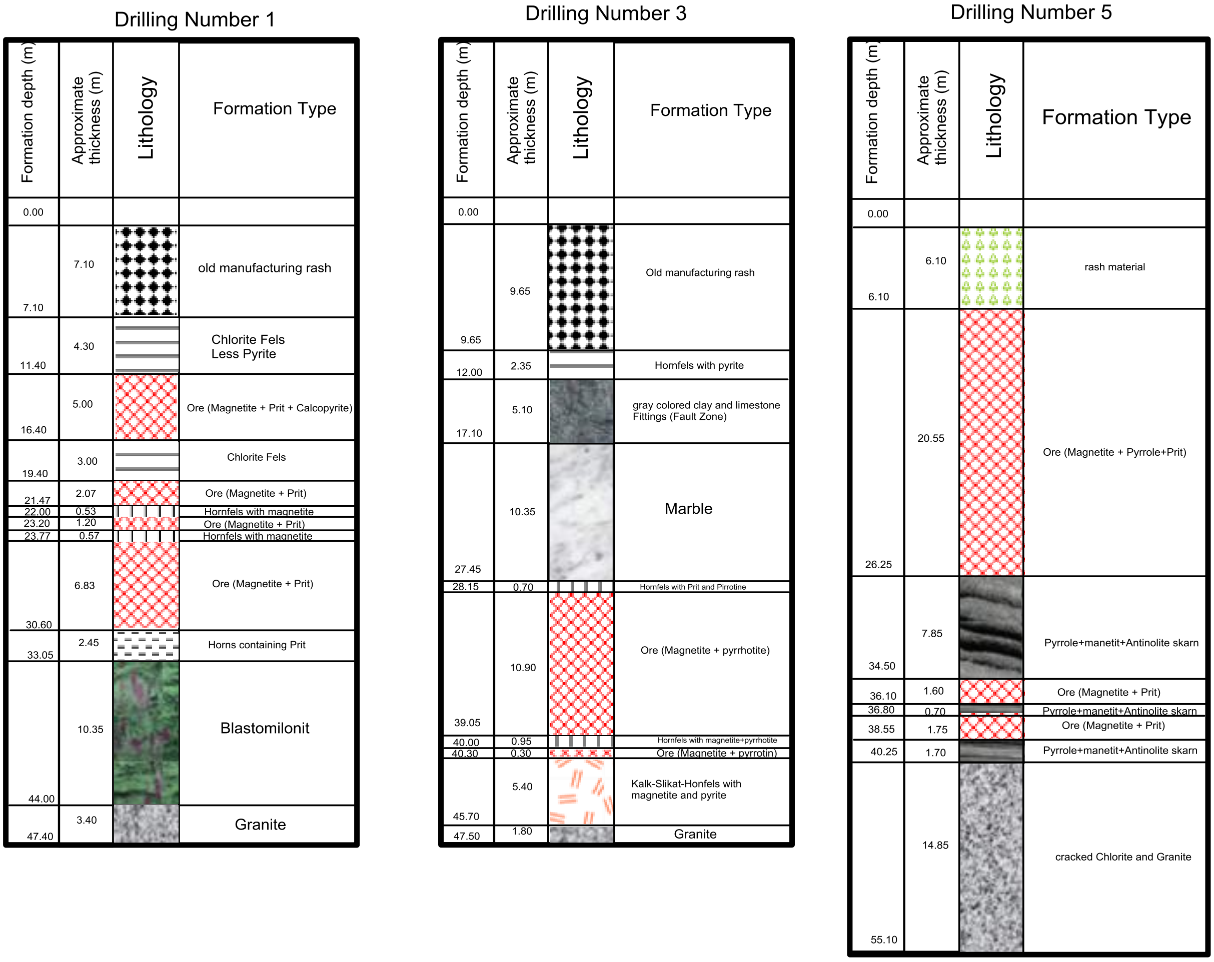

Figure 6: Drilling and geological formations in the area of iron mine in Emet region, Kütahya

Results and Discussion

In this article, CNN method was applied to magnetic anomaly map of iron mine area in Kütahya Emet region. The most important feature of the CNN method is to reveal the residual effects by evaluating the neighborhood relations (Figure 5). As a result of the CNN of the mine site in Figure 5a, the boundaries of the mine area have been exposed to reveal the location of the mine site. In this study, 3 drilling locations were investigated. When the drilling 1 is examined, it is seen that the iron ore starting at 11.40 meters has a thickness of approximately 19.20 meters. A-A1 section taken in this region is given in figure 7a.

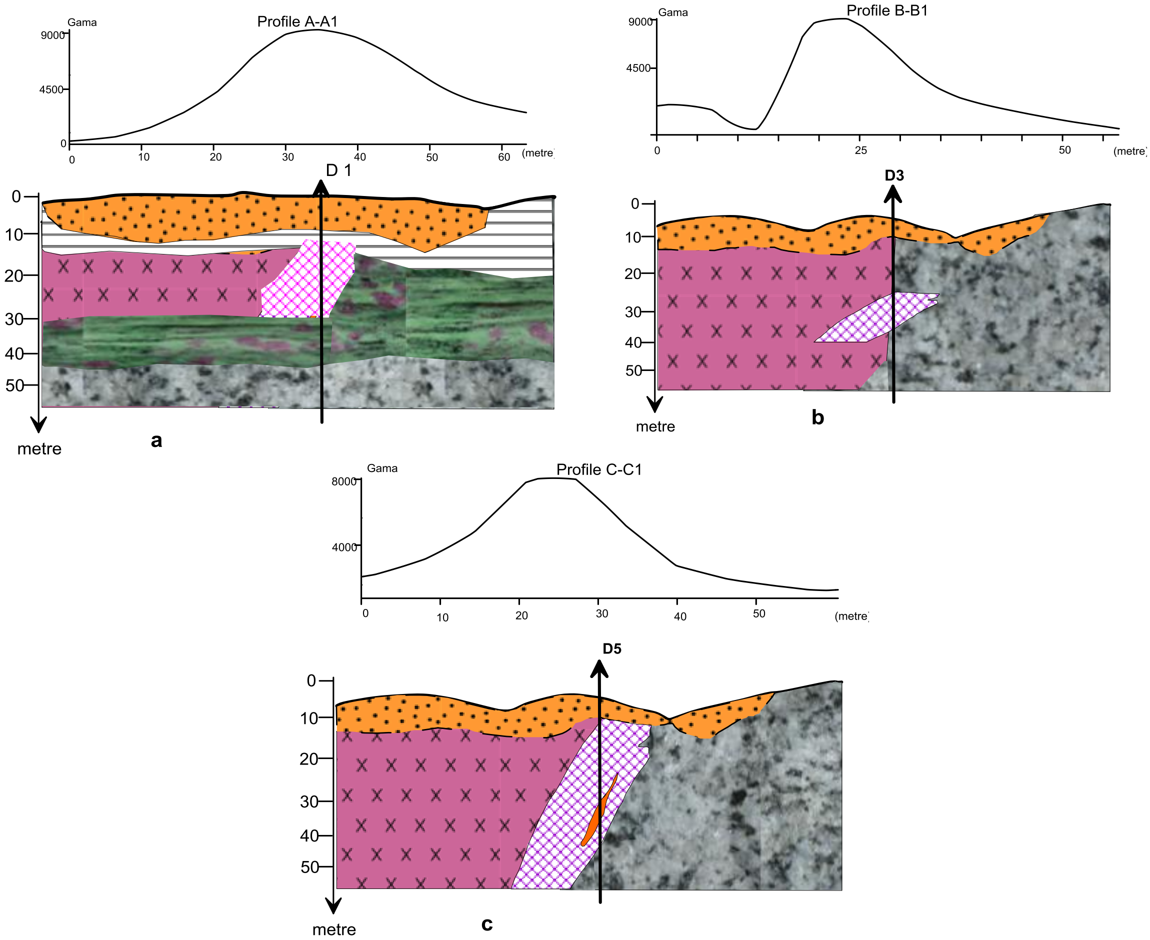

Figure 7: CNN map taken from a) A-A1 section b) B-B1 section c) C-C1 section

In the drilling 3, iron ore was cut at 28 meters and an approximate geological structure was modeled in B-B1 section taken from this region. In the drilling 5, iron ore starting at approximately 6.10 meters was cut at a thickness of 21 meters and an ore of about 3.35 meters was found again after 8 meters of the prot. As a result, the anomalies were found to be effective in cases where magnetic properties were strong by applying CNN method to the anomaly map obtained after magnetic work done in Kütahya şekil Emet region.

Acknowledgement

In this study, I would like to thank MTA, its employees and especially Geophysics engineer Ali Rıza Midilli, whose data I used.

Reference

[1]. Tuncel S., Arı N., Yoleri B. And Şahiner M., (2017), Iron in the world and in Turkey, Maden Tetkik ve Arama Genel Müdürlüğü.

[2]. Albora A. M., Uçan O. N., Özmen A. and Tulay Ö., (2001a), Evaluation of Sivas-Divrigi Region Akdag Iron Ore Deposits Using Cellular Neural Network, Journal of Applied Geophysics, 46, 129-142.

[3]. Albora A.M., Özmen A., Uçan O.M., (2001b), Residual Separation of Magnetic Fields Using A Cellular Neural Network Approach, Pure And Applied Geophysics, vol.158, pp.1797-1818, 2001.
[4]. Uçan, O.N., Bilgili, E. and Albora, A.M. (2002) Magnetic Anomaly Separation using Genetic Cellular Neural Networks" Journal of the Balkan Geophysical Society. 5,65-7.
[5]. Bilgili E., Göknar Z.C., Albora A.M., Uçan O.M. (2005), Potential Anomaly separation and archeological site localization using genetically trained Multi Level-Cellular Neural Network, ETRI Journal, 27, 3, 294-303.
[6]. Aydogan, D., Elmas, A., Albora, A. M. and Ucan, O. N. (2005), A new approach to the structural features of the Aegean Sea: Cellular Neural Network, Marine Geophysical Researches, 26, 1, 1-15.
[7]. Albora, A. M., Bal, A., Ucan, O. N. (2007), A new approach for border detection of Dumluca (Turkey) iron ore area: Wavelet Cellular Neural Networks, Pure and Applied Geophysics, 164, 119-215.
[8]. Albora, A. M., Ucan, O. N., Aydoğan, A. (2007), Tectonic Modeling of Konya-Beysehir Region (Turkey) Using Cellular Neural Networks, Annals of Geophysics, 50, 5, 603-614.
[9]. Albora, A. M., Uçan, O.N., Özmen A. and Özkan, T., 2001b, Separation of Bouguer anomaly map using cellular neural network. Journal of Applied Geophysics, 46, 129-142.
[10]. Albora, A. M., Özmen, A. ve Uçan, O. N., 2001a, Residual Separation of Magnetic Fields Using a Cellular Neural Network Approach, Pure and Applied Geophysics, 158, 1797-1818.
[11]. Midilli, A., Kütahya-Emet-Çatak bölgesi demir yatakları Manyetometrik Etüd raporu. MTA Maden Etüd Dağiresi.
[12]. Gün, H, - Bingöl, E., Akdeniz, N., Günay, E, (1976), Géologie du Bassin tertiaire des Regions Nord-Est du massif Menderes. Bull, Soc, Géol France t, XVXn, no: 2, p. 451-458.