Soil surface seismic hazard maps for the proposed site of Nasser New City, West Assiut, Egypt

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Abstract
The objective of this paper was to develop the soil surface seismic hazard maps for the proposed site of Nasser New City, West Assiut, based on probabilistic seismic hazard assessment, mainly in terms of the mean peak ground acceleration (PGA) and spectral acceleration (SA) values. Assessment of soil surface seismic hazard maps is required for disaster preparedness, risk, and hazard mitigation decisions for the study area. To carry out this assessment, soil profile is defined based on soil shear wave velocity that is global Vs30 of USGS. These velocities are converted to site classification based upon the National Earthquake Hazards Reduction Program (NEHRP) guidelines. A seismic hazard evaluation with level hazard 10% probability of exceedance in 50 years in terms of 5% damped peak ground acceleration and spectral acceleration was carried out, PGA and SA values at bedrock, at 0.1, 0.5, 1.0, and 2.0 s spectral period, were calculated at central part of Nasser New City. Using site amplification factors corresponding to various site classes based on Vs30, spatial variation of SA at spectral periods 0.1, 0.5, 1.0, and 2.0 s for 475 years as return period is demonstrated as maps. Results of this work are important for civil engineering purposes, land use planning, and resistant structure design for earthquake.

Keywords Probabilistic seismic hazard analysis (PSHA) · Spectral acceleration (SA) · Site classification · Amplification factor · Nasser city, Assiut

Introduction
The Egyptian government issued a presidential decree NO. 78 in 2017, to establish a new city in West Assiut City and called Nasser City; site classification and seismic hazard assessment are important to mitigation of seismic risk at this new city. The study area is located on the Western bank of Nile valley and lies about 12 km south West Assiut City and about 5 km east Assiut International Airport (Fig. 1). The proposed area is situated between latitudes 27.029° and 27.128° N and longitudes 31.046° and 31.130° E.

Earthquake ground motion maps such as seismic hazard maps provide critical information for a variety of societal applications. They support decision-making processes that include the development of regulatory legislation, the estimation of insurance rates, land-use planning, and emergency planning. Since local site conditions strongly affect the characteristics of ground motion, estimating first-order site conditions is essential for improving the information delivered by such maps.

Proposed site of Nasser New City in West Assiut was selected for this study due to the government of Egypt placing a general plan aiming to construct a new cities in desert land such as (new capital and Al-Almean new city) one of those cities is Nasser city in Assiut area, also the recorded earthquake activity within a circle with 400 km radius around the proposed area shows a clustering and trending of the activity at specific tectonic structures and faults. Some clusters were observed along the Nile Valley (e.g., southwest of Aswan, northeast of Abu Simbel, north of Idfu, west of Sohag, Shadwan Island, south part of Gulf of Aqaba and Gulf of Suez, southeast of Beni Suef and Dahshour “southwest of Cairo”). Due to these reasons, site classification, amplification
factor, and surface seismic hazard maps are very important for this new city (Nasser city) to mitigate the seismic risk.

Vs30 values are used to estimate the site classification and amplification factor, probabilistic seismic hazard analysis (PSHA) method is used to evaluate the seismic hazard using crisis 2014 software program, and the peak ground acceleration (PGA) and spectral acceleration (SA) values for return period 475 years, at 0.1, 0.5, 1, and 2 s spectral period were calculated.

Geological and tectonic setting

The topography of the studied area shows few irregularities in the surface with elevations ranging from 165 to 240 m above sea level (Fig. 2A). The exposed Lower Eocene deposits in the environs of Assiut are classified into three units from base to top (Omara et al. 1970) as (a) Zawia Formation (b) Drunka Formation, and (c) Matmer Formation (Fig. 2B). Hard massive limestone is exposed on the surface in certain localities of the area. The soil of surface is composed of gravel and silt, and also small-scale karstic topographical features as caves and sinkholes in the limestone are observed west of Gabal Drunka.

The rocks cropping out in the West Assiut area are sedimentary in origin, with an age from Lower Eocene to Quaternary (Fig. 3A). The Lower Eocene rocks occurred as the plateau bordering the Nile Valley. In sub-surface, the bottom of the Nile Valley belongs to the Lower Eocene rocks. Gorge of the Nile is filled by Quaternary and Pliocene sediments. Pliocene sediments consist of clay with sand interbeds, and are unconformably resting on the Eocene carbonate. Deposits of Quaternary are composed of gravel and sand in generally covered by silty clay layers (Fig. 3A).
The area under study is located in West Assiut City (Fig. 3A) on the plateau consisting of Lower Eocene bedded limestone with local reefal or lagoon and local cherty nodules and flint bands. It ranges from well-bedded and weathered limestone in the western scarp to chalky limestone east of the area. The exposed Lower Eocene deposits in Assiut are classified into two units from base to top, Drunka Formation and Minia Formation. The structural setting of Assiut area has been studied by many authors including Said (1962), Youssef et al. (1977), Said (1981), Nakhla et al. (1986), and Rizkalla (1989). Surface structures are including faulting, fissures, and cracks that appear at the surface (Youssef et al. 1977). It is

![Fig. 2](image)

**Fig. 2**  A Elevation map of the study area. B Stratigraphic cross section in the western scarp of Drunka village (modified after Omara et al. 1970)

![Fig. 3](image)

**Fig. 3**  A Geological map of the study area and its surrounding (modified after CONOCO 1987). B Structural map showing faulting in the study area (modified after EGSMA 1981)
found that the prevailing direction of surface faulting is the northwest as shown in Fig. 3B.

The shallow seismic refraction survey has been conducted near the study area by Sabah Hamed Shabaan 2008. Geoseismic cross section showed that the thickness of the first layer ranges from 2 to 28 m, which is gravel and silt, and the second layer is a limestone and considered as bedrock that exposed at the surface in some location.

Seismicity of the Assiut area

A characterization of the historical earthquake for the more than 4000 years prior to 1900 is that earthquakes can be described only on the basis of historical records of damage to villages, temples, and tombs, supplemented by felt reports independent of damage. Explicit studies of earthquake activity in Islamic records cover a major portion of the nearly 2000 years after the birth of Christ (Ambraseys 1961; Poirier and Taher 1980) but the preceding 3000 years of Egyptian history were not studied. According to Sawires et al. (2015), the region within a 400-km radius around Assiut area is affected by 11 seismic sources (Fig. 4); these zones are described as the following:

(EG-01) Seismogenic source

The EG-01 (Tiran–Dakar Basin) seismogenic source lies at the southern part of the Gulf of Aqaba. It includes the MS 4.4, February 2, 2006, earthquake. There are no historical earthquakes included in this source zone. Most of the available FMSs inside this area source reflect normal-faulting mechanism with a minor strike-slip component.

(EG-02) Seismogenic source

The EG-02 (Aragonese Basin) seismogenic source lies to the north of the previous EG-01 zone, and is considered the focal area of the MW 7.2, November 22, 1995, earthquake, which is considered the largest event to occur along the DST in the last century. No historical events were reported in this area source.

Central Red Sea (EG-13) seismogenic source

The EG-13 Central Egyptian Red Sea seismogenic source corresponds to the region north of latitude 24° 30' N. Recent recorded seismicity could indicate the expected location of the axial rift. In this zone, the degree of seismicity is relatively low and scattered, compared to the previous zone. Like the previous one, there is only one historical event included here. It is
the I max V, 1899 earthquake. The maximum observed magnitude along this source corresponds to the mb 4.7 (MS 5.1), July 30, 2006, earthquake.

Northern Red Sea (EG-14) seismogenic source

The EG-14 Northern Egyptian Red Sea seismogenic source is characterized by higher seismic activity than the previous two sources. This activity may be due to the juncture between the two gulfs (Ben-Menahem et al. 1976; Daggett et al. 1986). Daggett et al.’s (1986) studies of the low-magnitude seismicity shows that the high seismic activity of the Northern Red Sea is different from the activity at the southern part of the Gulf of Suez. In this seismic source, there are no related earthquakes before the year 1900. In addition, the mb 5.0 (MS 5.0) March 22, 1952, event represents the biggest recorded earthquake until now.

Southern Gulf of Suez (EG-15) seismogenic source

The EG-15 Southern Gulf of Suez seismogenic source is distinguished by intensive structural deformation. It is characterized by its relatively high seismic activity (Gergawi and El-Khashab 1968; Bosworth and Taviani 1996). The high rate of seismicity at the southern end of the Gulf of Suez is attributed to the crustal movements among the Arabian Plate, African Plate, and the Sinai Sub-plate.

Central Gulf of Suez (EG-16) seismogenic source

The seismic activity in the EG-16 Central Gulf of Suez seismogenic source is relatively low when compared with the previous source. The most important earthquake inside this area is the MS 6.2 March 6, 1900, event.

Northern Gulf of Suez (EG-17) seismogenic source

The EG-17 Northern Gulf of Suez seismogenic source is characterized by its low seismic activity. Two earthquakes have been catalogued, in the current study, before the year 1900. They are the I max VI, 742, and I max V, 1754 earthquakes.

Abu Dabbab (EG-21) seismicity source

The Abu Dabbab region is located in the central part of the Eastern Desert of Egypt. The moderate seismic activity and extremely tight clustering of low-magnitude earthquakes at Abu Dabbab suggests that the seismicity in this area is not directly related to regional tectonics. One possible explanation is that it could be related to magmatic intrusions into the Precambrian crust, but there is no direct evidence to support this hypothesis (Daggett et al. 1986).

The most important event included in this area source is the MS 5.3, November 12, 1955, earthquake.

Southern Aswan (EG-22) seismogenic source

The recent tectonic history of the Nasser’s Lake is complex and mainly controlled by faults, e.g., the Western Desert Fault System, which includes two major fault trends, N-S and E-W (Issawi 1969, 1978).

The history of the seismic record of Aswan area reflects a matter of debate (Deif et al. 2009). This is because Ambraseys et al. (1994) showed no historical earthquakes in this source, while Maamoun et al. (1984) showed two historical earthquakes with epicentral intensity VII almost at the same location of the MW 5.8, November 14, 1981, earthquake. These two events occurred in 1210 B.C. and in 1854.

Luxor-Southern Beni Suef (EG-23) seismogenic source

To the north of Aswan area, in the region between Luxor and Southern Beni Suef, along the Nile River, there is a low seismicity level, which nearly coincides with the main trend of the Nile River. This active area has been considered, in the current study, a separate seismogenic source. Several historical earthquakes are reported to occur along the Nile River in this area source that may be due to the high population density along the Nile River in the ancient times. These earthquakes are the 600 B.C., 27 B.C., 857, 967, 997, 1264, 1299, 1694, 1778, and 1850 events. Their range of intensities is from V to VIII.

Beni Suef–Cairo–Suez District (EG-24) seismogenic source

To the north of the previous zone and to the west of the Gulf of Suez, there is a moderate seismic activity between Beni Suef and Cairo, on the River Nile, to Suez, on the apex of the Gulf of Suez. This area source includes many important earthquakes. They are (i) the mb 4.8, April 29, 1974, Abu Hammad earthquake, (ii) the mb 4.9 (MS 4.8), March 29, 1984, Wadi Hagul earthquake, which is located to the southwest of Suez (it was strongly felt in Suez, Ismailia, and Cairo, and a large number of aftershocks were recorded by nearby temporary stations), (iii) the mb 5.0, January 2, 1987, Ismailia event, and (iv) the MS 5.9, October 12, 1992, Dahshour earthquake (the most destructive event).

Data and methodology

In this paper, the probabilistic seismic hazard analysis (PSHA) method was used. PSHA includes obtaining the probability that it has become widespread to cover a wide variety of seismic hazard assessments, including the compilation of seismic zoning maps, microzoning, and seismic hazard assessments.
for design structures. The objective of the PSHA is to quantify the probability of excess ground motion at a given time interval and at a specified time interval. According to Cornell (1968), as illustrated in (Fig. 5), the fundamental elements of the PSHA are the following:

1. Seismic source model
2. Earthquake magnitude recurrence model
3. Ground-motion attenuation model
4. Approach, software code, and results

Earthquake catalogs, along with a clear understanding of the geology and seismotectonic environment, form the fundamental basis for the concept of a model of seismic source, which is the main element required to execute PSHA. In the absence of an updated and reliable earthquake catalog based on the original data for the study region, compiling a new one from the available sources was required. Thus, a revised and coherent earthquake database located in Egypt and its surrounding in the period 2200 B.C. compiled until 2013 AD (Sawires et al. 2015, 2016a) is used in this study. Another relevant and crucial information for any seismic-hazard research is the definition and characterization of the seismic source zones of each area. The considered model of seismic source consists of 11 shallow depth ($h \leq 35$ km) seismic zones for the study area and its vicinity (Fig. 4). The parameter $b$, or $\beta$, has received considerable attention from seismologists, geologists, and earthquake engineers. As discussed before, this parameter defines the relative proportion of earthquakes of various magnitudes occurring in a specific region. The $b$-value has an inverse relation with the likelihood, so that the likelihood of larger magnitudes relative to small magnitudes diminishes as the $b$-value increases.

The range of magnitudes considered in the hazard analysis is doubly bounded (Cornell and Vanmarcke 1969). At the lowest magnitude, it is bounded to a minimum magnitude ($M_{\text{min}}$), which is considered the appropriate $M_{\text{min}}$ to use for buildings of good design and construction (e.g., McCann and Reed 1990). In the highest magnitudes, the distribution is truncated at an upper-bound value $M_{\text{max}}$, which is the magnitude of the maximum “possible” earthquake that seismic source can host.

Table 1 shows the basic data for each source that was used in calculating PSHA such as $b$-value, annual frequency of earthquakes, and maximum observed magnitude for the delineated seismic source zones around the study area (Sawires et al. 2016b).

Average shear wave velocity up to a depth of 30 m ($V_s30$) is one of the important methods for inferring the NEHRP site classification and estimating the amplification factor. The United States Geological Survey (USGS) operates the USGS Global $V_s30$ Map Server (USGS 2013) through correlations between the topographic slope and the measured $V_s30$ values. The map in Fig. 6 shows the values of $V_s30$ in the study area in the range 200 to 620 m/s. The data for this map have been downloaded from https://earthquake.usgs.gov/data/vs30.

In general, the value increases for $V_s30$ as the elevation increases, so we find the northeastern part in the study area...
Table 1: b-value, annual rate of earthquakes, and maximum observed magnitude for the delineated seismic source zones around the study area after (Sawires et al. 2016b)

| Source zone | b-value | Yearly Number of Earthquakes | Observed M_max/I_max |
|-------------|---------|------------------------------|----------------------|
|             |         | Above M_w 4.0 | Above M_w 5.0 |             |
| EG-01       | 1.13 ± 0.05 | 0.980 ± 0.083 | 0.052 ± 0.007 | m_b 4.4 on 2006/02/02 |
| EG-02       | 0.98 ± 0.06 | 0.495 ± 0.064 | 0.038 ± 0.005 | m_w 7.2 on 1995/11/22 |
| EG-13       | 0.91 ± 0.06 | 0.303 ± 0.044 | 0.047 ± 0.005 | m_b 4.7 on 2006/07/30 |
| EG-14       | 1.13 ± 0.07 | 0.643 ± 0.061 | 0.072 ± 0.007 | m_w 5.0 on 1952/03/22 |
| EG-15       | 1.06 ± 0.04 | 0.835 ± 0.079 | 0.049 ± 0.006 | M_w 6.8 on 1969/03/31 |
| EG-16       | 0.80 ± 0.06 | 0.309 ± 0.040 | 0.052 ± 0.007 | M_w 6.2 on 1900/03/06 |
| EG-17       | 0.138 ± 0.029 | 0.019 ± 0.004 | 0.86 ± 0.08 | M_s 6.6 on 1754 A.D |
| EG-20       | 0.87 ± 0.09 | 0.371 ± 0.042 | 0.050 ± 0.006 | m_b 6.2 on 1952/03/22 |
| EG-21       | 0.79 ± 0.07 | 0.586 ± 0.060 | 0.095 ± 0.010 | M_w 5.8 on 1981/11/14 |
| EG-22       | 0.73 ± 0.05 | 0.295 ± 0.051 | 0.86 ± 0.08 | M_s 6.2 on 1955/11/12 |
| EG-23       | 0.596 ± 0.076 | 0.061 ± 0.008 | 0.99 ± 0.06 | M_s 6.2 on 1262 A.D |

with greater values as against Vs30 (400–620 m/s) and also the highest elevation (235–245 m) (Fig. 6).

An amplification factor (AF) is often used to express local site effects, and defined as the ratio of ground motion at the surface to the ground motion at bedrock at the same site. Ground motion amplification factors can be calculated, by evaluating the spectral values of the acceleration response for different periods. Borcherdt (1994b) and Dobry et al. (2000) described how the site factors are estimated (Fig. 7) using the following expressions:

Fig. 6 Global Vs30 distribution map, merged with elevation contour line
where $V_{\text{ref}} = 1050 \text{ m/s}$ and $ma$ and $mv$ are fit coefficients that vary with input motion amplitude to capture trends in the simulations with the results shown in the legend of Fig. 7.

In general, the methodology throughout the study is divided into two steps (Fig. 8). The first step is the assessment of probabilistic seismic hazard in terms of peak ground acceleration and spectrum acceleration at bedrock. Secondly, estimate site classification and calculate the amplification factor;

$$F_a = \left( \frac{V_{\text{ref}}}{V_{S30}} \right)^{ma}$$

$$F_v = \left( \frac{V_{\text{ref}}}{V_{S30}} \right)^{mv}$$

**Fig. 7** (a) Short-period $F_a$ and (b) mid-period $F_v$ amplification factors. Parameters $ma$ and $mv$ are slopes of the amplification factors with $V_{S30}$ in log-log space; PGAr corresponds to the input ground motion level on rock in units of g (Dobry et al. 2000). Reported slopes from Borchert (1994a, 1994b)

**Fig. 8** Flow chart of research methodology
then soil surface hazard maps were found with multiplying calculated spectral acceleration at bedrock by the calculated amplification factor at the study area. The description of each methodology can be summarized in the flow chart (Fig. 8).

Results and discussion

a: Site classification

The site classification for the study area was determined according to NEHRP (2001) guidelines based on Vs30. NEHRP soil classification was developed from theoretical analysis and measurements in California (Borcherdt 1994a). This method is recommended by the Earthquake Construction Safety Council (BSSC 1998) in the NEHRP recommended items. Table 2 shows the NEHRP classification code as it is defined in terms of Vs30.

The site classification scheme, which has been developed for the study area, includes two generalized site classes (class C and class D). The site classification map for the investigated area (Fig. 9) shows that the most northeastern parts and narrow areas along western and southern parts belong to C category which have Vs30 values from 365 to 620 m/s. Other areas belong to D category at middle, most southern, and most western parts of the investigated area which have Vs30 values from 200 to 365 m/s.

b: Seismic hazard at bed rock for the study area

Peak ground acceleration (PGA) and spectral acceleration values for damping level of 5% at 10% probability of exceedance in 50 years, which correspond to return period 475 years, at 0.1, 0.5, 1.0, and 2.0 s spectral period were calculated at central part of Nasser New City (area under study) using crisis 2014 software program and Zhao et al. (2006) as attenuation model. The results are summarized in Table 3

c: Site effect on ground shaking and amplification factor

According to the above equations (1 and 2) and Vs30 map, the amplification factor is calculated for the study area as shown in (Fig. 10).

Table 2 NEHRP site classification 2001

| Type | Definition | Vs30 |
|------|------------|------|
| A    | Hard rock  | > 5000 ft/s (1524 m/s) |
| B    | Rock       | Between 2500 and 5000 ft/s (762 to 1524 m/sec) |
| C    | Soft rock and very dense soil | Between 1200 and 2500 ft/s (365 to 762 m/sec) |
| D    | Stiff soil | Between 600 and 1200 ft/s (183 to 365 m/sec) |
| E    | Soft soil  | < 600 ft/s (183 m/s) |
| F    | Poor soil  | > 10 feet of peats or highly organic clays |
|      |            | > 10 feet of peats or high plasticity clays |
|      |            | > 120 feet of soft or medium stiff clays |

Table 3 Peak ground acceleration (PGA) and spectral acceleration values for bedrock at the study area

| Return periods | PGA (g) | 0.1 S (g) | 0.5 S (g) | 1 S (g) | 2 S (g) | $T_{max}$ (s) | $SA_{max}$ (g) |
|----------------|---------|-----------|-----------|---------|---------|---------------|----------------|
| 475            | 0.11    | 0.19      | 0.13      | 0.084   | 0.055   | 0.1           | 0.19           |

Fig. 9 Site classes according to the NEHRP code
d: Soil surface hazard maps

Deterministically, soil surface hazard maps at spectral periods 0.1, 0.5, 1.0, and 2.0 s were found with multiplying calculated spectral acceleration at base rock by the calculated amplification factor at the corners of design grid of the study area and mapped in ArcGIS program.

The soil surface hazard maps (Figs. 11 to 12) show distribution of spectral acceleration (SA) at 0.1, 0.5, 1, and 2 s spectral periods, respectively, for return period 475 years. The couture map (Fig. 11A) shows spectral acceleration value in the range of 0.235 to 0.291 g at most northeastern part and other parts, and 0.291–0.347 g at most southern and middle parts of the study area for 0.1 s spectral period, while Fig. 11B shows

![Fig. 10](image1.png)

**Fig. 10** A Amplification factor at the surface soil for short periods (0.1–0.5s) and B for mid periods (> 0.5–2s)

![Fig. 11](image2.png)

**Fig. 11** A Probabilistic hazard map at soil surface 0.1 s spectral acceleration in g for 475 years return period. B Probabilistic hazard map in terms of ground surface 0.5 s spectral acceleration in g for 475 years return period
shows value from 0.160 g to reach 0.198 g at most northeastern part and other areas, and most southern and middle parts in range 0.198 to 0.237 g at 0.5 s spectral period. The iso-acceleration map (Fig. 12A) shows distribution of SA in the range 0.118 g to 0.245 g at 1 s spectral period, the most northern, most eastern, and north middle parts of the study area in the range 0.118–0.182 g, while the values in the range 0.182 to 0.245 g are represented in most southwestern part and south middle parts; the distribution of SA at 2 s spectral period (Fig. 12B) illustrates value about 0.077 to 0.119 g at most northern, most eastern, and north middle parts, while the values in the range 0.119–0.160 g are present in most southwestern part and south middle parts of the study area.

**Conclusion and recommendations**

The production of seismic hazard maps can be used in hazard mitigation strategies such as emergency response and land-use planning. These maps are important for site evaluations, which is requisite for critical constructions; it also help in design of buried lines as water pipe and sewage pipe, gas, and oil lines and electrical and communication cables.

The average shear wave velocity in the first 30 m of the soil column shows that Vs30 ranges from 200 to 620 m/s; these velocities is transformed into site classification based upon the NEHRP guidelines. The site classification for the study area includes two site classes, Class C and Class D; most northeastern parts and narrow areas along western and southern parts and other parts of the study area belong to C categories which have Vs30 values from 365 to 620 m/s, while the most study areas (middle parts, most southern, most western parts, and other areas which have Vs30 values from 200 to 365 m/s) belong to D category.

The seismic hazard has been computed using the CRISIS 2014 software code (Ordaz et al. 2014), and using Spectral acceleration (SA) at bedrock and amplification factor values at the surface of the study area for 0.1, 0.5, 1, and 2 s spectral period and 475 years as return period the surface Spectral acceleration values are calculated and mapped in Arc GIS program.. Soil surface hazard maps show that the maximum ground motions reach 0.235 and 0.347 g with a period of 0.1 s at 475 years return periods and in general increasing from northeastern parts to southwestern parts of the study area.

**Recommendations**

1. Most northeastern parts, narrow areas along western and southern parts, which correspond to site class C in the proposed site classification scheme, is characterized by low amplification of seismic waves (site effect) during earthquakes; therefore, the territory may be considered relatively safe area for construction of buildings. The class D may be considered unfavorable for tall buildings.

2. Seismic hazard assessment at Nasser New City in West Assiut area is considered the most important in land use planning and civil engineering purposes in this new city to construct earthquake-resistant structure design.
List of abbreviations and symbols

PSHA ⇔ probabilistic seismic hazard analysis
NEHRP ⇔ National Earthquake Hazard Reduction Program
M₀ ⇔ moment magnitude
SA ⇔ spectral acceleration
PGA ⇔ peak ground acceleration
AF ⇔ amplification factor
Iₘₚ ⇔ maximum intensity
Mₘᵦ ⇔ minimum magnitude
Mₘₜ ⇔ maximum magnitude
Fₕ₁ ⇔ short-period amplification factor
Fₗ₂ ⇔ mid-period amplification factor
BSSC ⇔ Building Seismic Safety Council
Vs30 ⇔ average shear wave velocity up to a depth of 30 meters
EGSMA ⇔ Egyptian Geological Survey and Mining Authority
USGS ⇔ United States Geological Survey

Declarations

Conflict of interest
The authors declare that they have no competing interests.

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