



The Geology of Be'er Sheva Quarry

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By: Amir Eidelman and Lior Enmar

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am Geology
Amir Eidelman (Phd) - Geologist

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בית המדרש של ישראל

Dr. Amir Eidelman Geologist

5 Shimon st. Jerusalem 93629 Tl. 972-2-6727372 Fax. 972-2-6727370 Cell 972-52-2383774
amgeolog@netvision.net.il / amgeolog@gmail.com

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1. THE UNIQUENESS OF THE BE'ER SHEVA QUARRY

The **Be'er Sheva** quarry is delineated by 3 streets: Yehuda HaLevi, Shimon Bar Giora and Rabbi Akiva. The dimensions of the quarry are about 200 by 300 meters and its depth is about 15 meters.

The quarry has been abandoned for more than 100 years. During the past decades the quarry has been serving as an urban open space for the residents of Be'er Sheva.

The quarry combines two unique geological aspects:

- Evidence of an ancient huge canyon and fiord that crossed the Be'er Sheva area several millions of years ago.
- Excellent exposures of different building stones that were used during the Ottoman period, at the beginning of the 20th century. The Governor Residence and the complex of the railway station buildings in the Old City of Be'er Sheva represent the architectural use of these building stones.

2. ANCIENT CANYONS AND FIORDS

Several millions of years ago a long river flowed from the area of Jordan on the east, to the Mediterranean Sea in the west. This was long before the Dead Sea Rift Valley (that today separates between Israel and Jordan) was formed. On its route the water stream eroded rock fragments and carried gravels of unique rock types from Jordan to the Be'er Sheva area. The mouth of that ancient river was near the shore of Gaza, about 50 km north-west of Be'er Sheva.

In the Be'er Sheva area the bottom of those ancient river beds are buried about 200 m below the present surface. In the Gaza area, close to the Mediterranean Sea, the bottom of the ancient river lies about 1,400 m below the present surface (Figure 1). One has to imagine a river flowing at the bottom of a very deep canyon gorge with very steep cliffs on its sides, crossing the city of Be'er Sheva. The canyon is currently filled by sediments which seal the canyon. The ancient Canyon of Be'er Sheva is not the only one. There are many known sealed canyons around the Mediterranean Sea. The most famous are the sealed canyons of the Nile River in Egypt and the Rhone River in France.

The key to understanding the evolution of the ancient canyons came from a completely different area of research. It was the study of the geology of salt, gypsum and potash deposits at the bottom of the Mediterranean Sea that resulted in the explanation of the evolution of the sealed canyons. Karl Mayer-Eymar, a Swiss geologist, was the first to describe in 1867 a salt diapir¹ in Sicily near the Strait of

¹ Salt layers found at depth intrude vertically into the surrounding rock strata, forming a salt dome.

Messina. It took about 100 years of geological research including drilling campaigns and mapping the Mediterranean Sea beds, to reveal an amazing geological story.

Evaporite minerals such as salt and gypsum crystallize in closed basins, where seawater concentration increases. The extreme depositional conditions occur when the sea water evaporation rate is greater than river inflow into the basin – a phenomena named "Evaporative Loss". The deposition of evaporites can be demonstrated by a simple experiment of boiling sea water. The mineral Calcite (CaCO_3) crystallizes first with the evaporation of 68% of the original volume. The remaining 32% sea water becomes concentrated brine. The mineral Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) crystallizes during the evaporation of an additional 20% and the salt minerals Halite (NaCl) and Carnalite ($\text{KMgCl}_3 \cdot 6\text{H}_2\text{O}$) crystallize from the remaining 12% of the original sea water volume. In nature such conditions occur for example in the Dead Sea in Israel and in the Great Salt Lake in the U.S.A.

The conclusions of the geological research indicated that around 5.3-5.9 million years ago, the Mediterranean Sea went into a cycle of partly or nearly complete desiccation, initiating the crystallization of the evaporite deposits at the bottom of the sea. This event is named “The Messinian Salinity Crisis (MSC)” after the salt diapir in Messina.

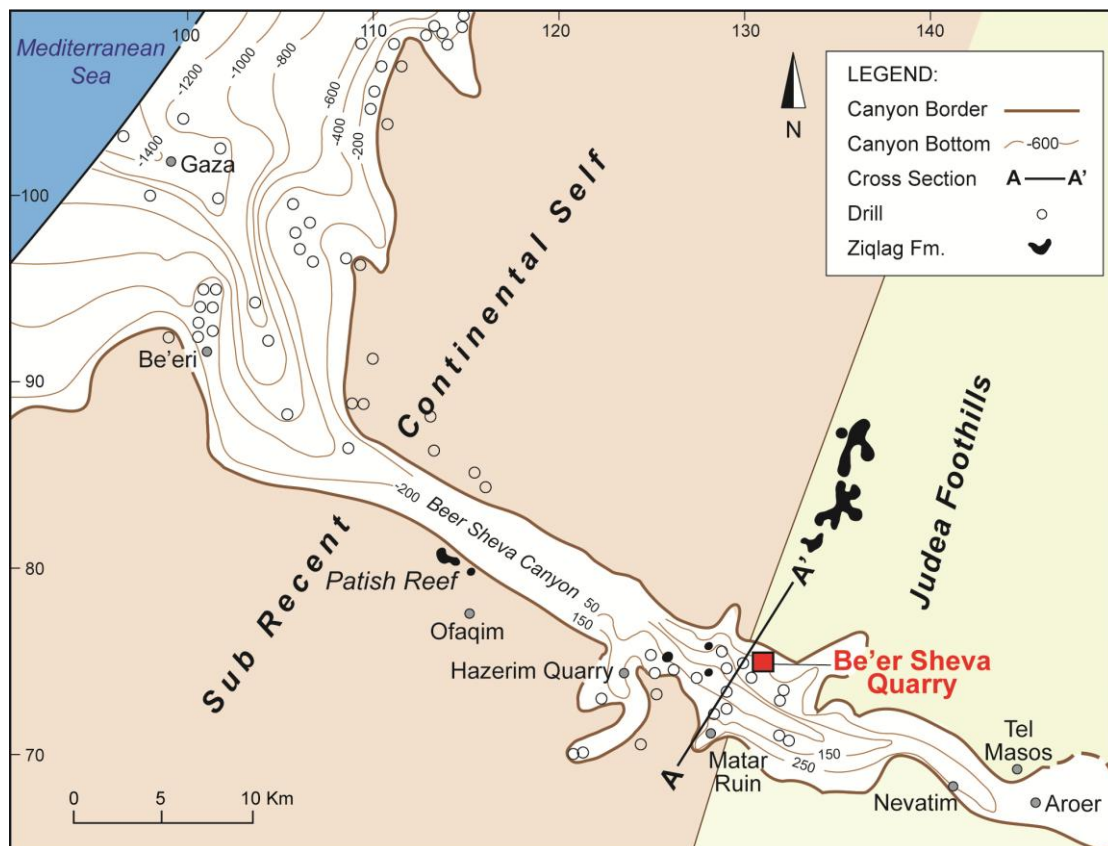


Figure 1: The course of the Be'er Sheva Canyon
(Source: Buchbinder and Zilberman 2004)

During the Messinian Salinity Crisis, rivers around the Mediterranean Sea incised their way to the 1,400 meters lowered sea level, creating long and deep canyons.

The fossiliferous layers in the Be'er Sheva quarry are evidence of the time when the deep canyon turned into a flooded fiord which was inhabited by reefs of small and large marine species that spread along the steep canyon slopes. In time, the deposition of the marine fossiliferous rocks mixed with sand and clay grains, filled and sealed the ancient canyon.

3. GEOLOGICAL HISTORY

The evolution of the Be'er Sheva Canyon begins around 20 million years ago as described below.

3.1. THE NEOGENE PERIOD (20 MILLION YEARS AGO)

The Mediterranean Sea was connected to the Atlantic Ocean in the west and to the Indian Ocean in the east.

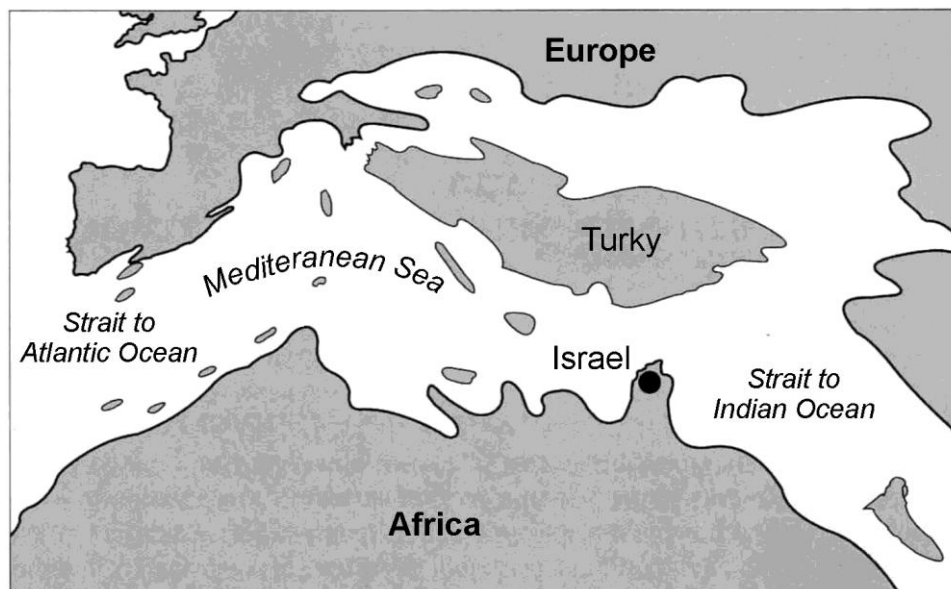


Figure 2: The straits which connected the Mediterranean Sea to the Atlantic Ocean and the Indian Ocean in the Neogene Period

3.2. BEGINNING OF THE MESSINIAN PERIOD (5.9 MILLION YEARS AGO)

A drift of the African plate to the north resulted in a closed basin of the Mediterranean Sea. The rivers flowed from the continents into the closed basin.

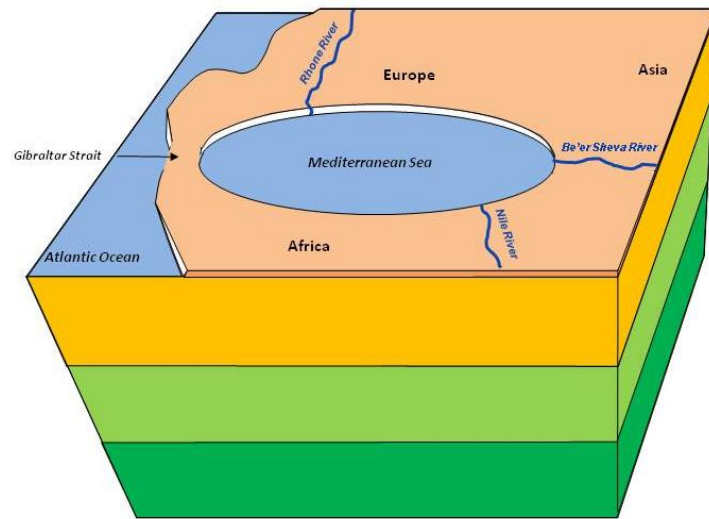


Figure 3: The Mediterranean Sea became a closed basin - schematic 3D diagram

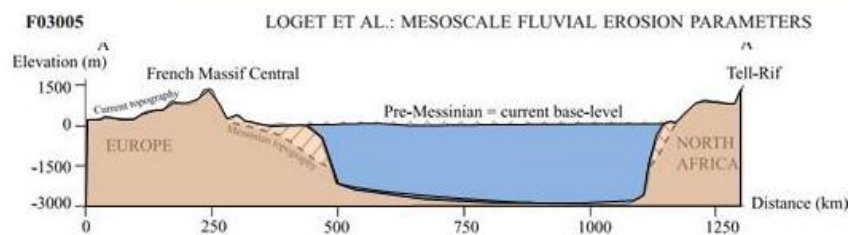


Figure 4: The Mediterranean Sea became a closed basin- schematic cross section
(Source: Loget et al. - MESOSCALE FLUVIAL EROSION PARAMETERS)

3.3. THE MESSINIAN PERIOD (5.9 TO 5.3 MILLION YEARS AGO)

Evaporative loss resulted in a dramatic lowering of the sea level and sea water concentration. During this time salt and gypsum were deposited at the bottom of the sea. This depositional event is named “The Messinian Salinity Crisis (MSC)”.



Figure 5: The Evaporative loss of the Mediterranean Sea - schematic sketch

Streams which drained into the lowered Mediterranean Sea eroded the river beds, forming deep canyons. Among the famous ancient canyons are the Nile, the Rhone, and the Be'er Sheva Rivers.

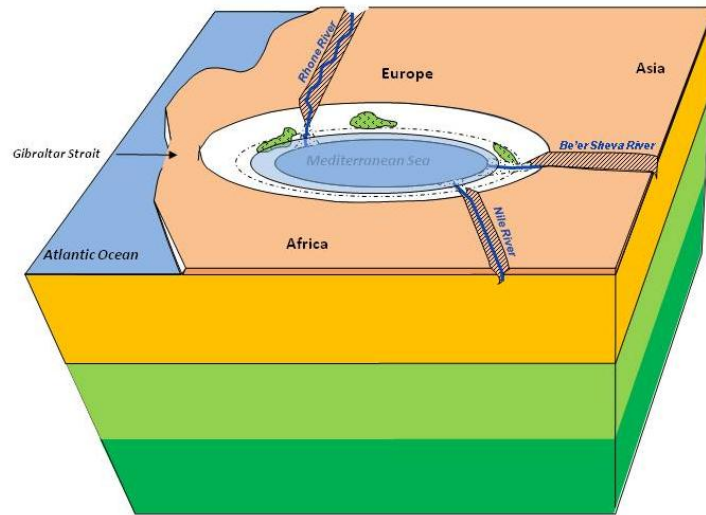


Figure 6: Deep canyons were formed around the Mediterranean Sea – Schematic 3D diagram

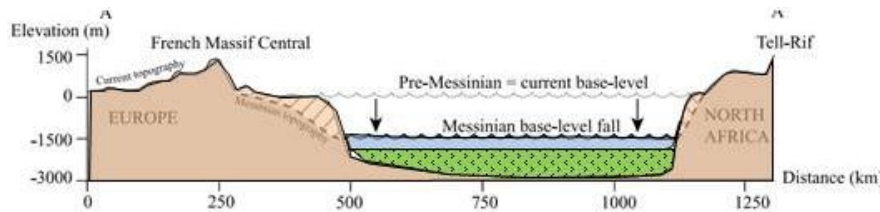


Figure 7: The drop in the Mediterranean Sea level and the deposition of evaporite minerals at the bottom of the sea- schematic cross section
(Source: Loget et al. - MESOSCALE FLUVIAL EROSION PARAMETERS)

At the end of the Messinian Period the Mediterranean Sea went into a cycle of partial desiccation and evaporite deposits covered large areas of the sea beds. Figure 8 illustrates: "the major evaporative basins and sediments found below the Mediterranean Sea". There are thousands of feet of salts found in these locations which represent the deepest points in the sea. The Atlantic Ocean does not have these types of sediments below them. These sediments are very similar to the thousands of feet of salt found below the Dead Sea which is clearly the result of salts precipitating from a closed basin sea. All of this salt was dissolved in sea water at some point in the past but is now removed by evaporation from the sea resulting in changes to the salinity of the seas over time" (from *The Salty Sea Part III: Are the Oceans Getting Saltier Over Time*, September 2012, by Natural History)

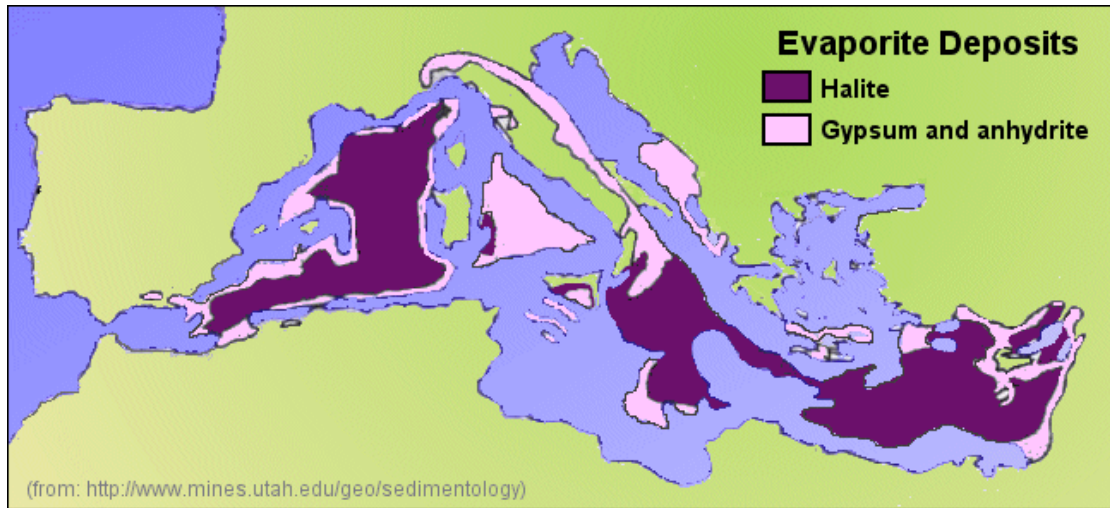


Figure 8: The major evaporative basins and sediments found below the Mediterranean Sea

3.4. END OF THE MESSINIAN PERIOD (5.3 MILLION YEARS AGO)

A drift of the African plate to the south resulted in the opening of the Strait of Gibraltar. Water from the Atlantic Ocean flowed into the Mediterranean Sea creating a waterfall of around 1.5 km in height. The refilling of the Mediterranean Sea is named the Zanclean Flood.

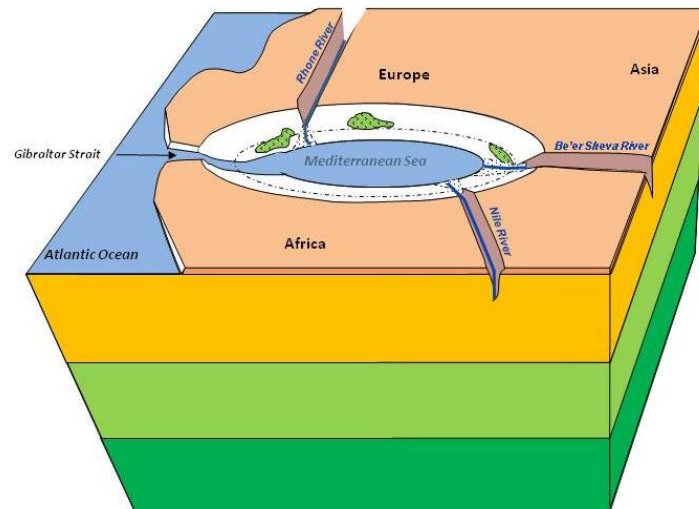


Figure 9: The opening of the Strait of Gibraltar forming a waterfall of around 1.5 km in height - schematic 3D diagram

3.5. THE PLIOCENE - PLEISTOCENE PERIOD (5.3 MILLION YEARS AGO)

The Mediterranean Sea flooded for a relatively short period (several months up to two years) and the rise in sea level reached daily heights above 10 m. The ancient canyons turned into fiords and in some places reefs developed along their banks.

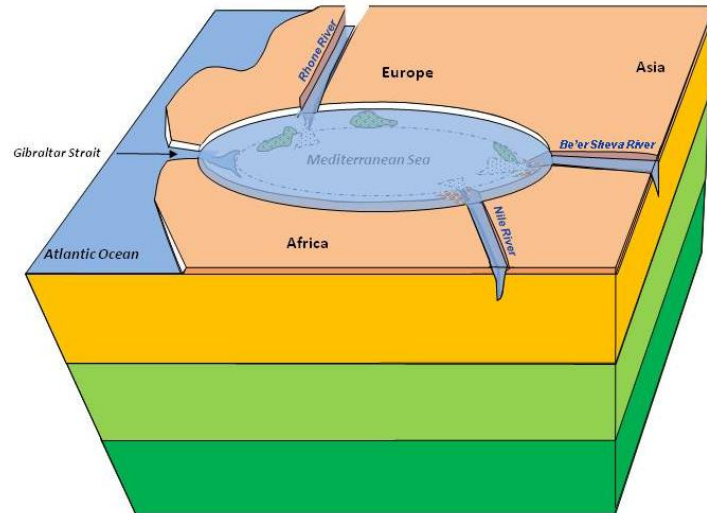


Figure 10: The rise in sea level resulted in the flooding of the ancient canyons and turned them in to fiords - schematic 3D diagram

Over time the canyons were filled by marine sediments with conspicuous fossils of shells and other marine creatures, and sediments that were carried into the fiords by the river streams from the continent, such as clay, sandstone and gravel. Eventually the ancient canyons were **completely** sealed by sediment.

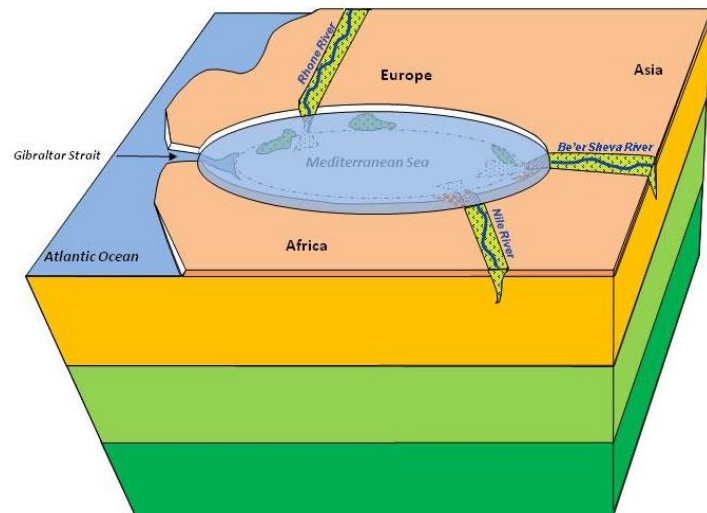


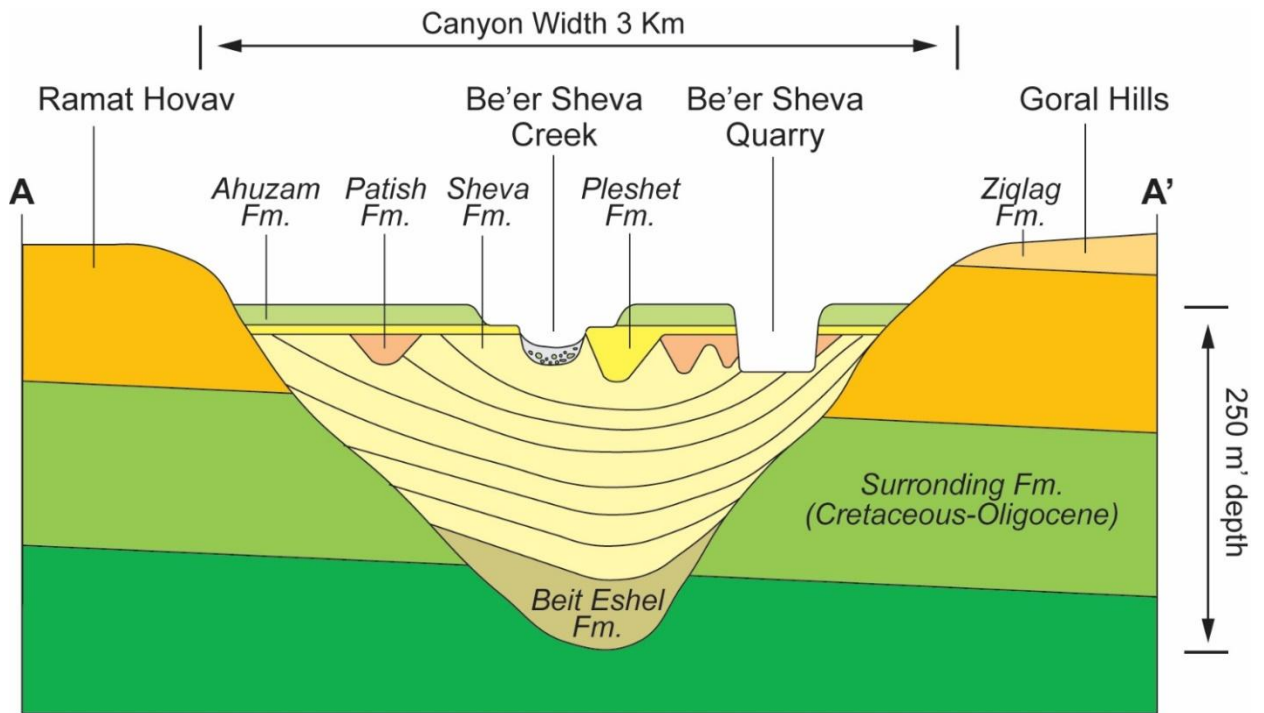
Figure 11: The ancient canyons are currently sealed by fossiliferous marine sediments mixed with sand and clay

The Grand Canyon of Be'er Sheva or the Afik Canyon is the name given by geologists to the sealed canyon. **The Ottoman quarry in Be'er Sheva forms a “geological window” to the upper parts of the ancient canyon.**

4. ROCK TYPES

4.1. GEOLOGICAL ROCK FORMATIONS

The rocks exposed in the quarry are related to three geological formations: the Sheva formation, the Patish formation, and the Pleshet formation. Among the rocks in the quarry are: chalk and limestone with fossil fragments and small grains of silt (Figure 12).







Millyon Years	Geological Period	Formation Name	Lithology
0	Plio-Pleistocene	Ahuzam	 Conglomerate
		Pleshet	 Marine Calcareous Sandstone
5.3	Miocene	Sheva-Patish	 Sandy Calcareenite
23		Beit Eshel	 Calcareenite

Figure 12: Rock types and the structure of the Be'er Sheva Canyon. (Schematic cross-section modified after Buchbinder and Zilberman 1997)

4.2. DISTRIBUTION OF ROCK TYPES

The rock formations in the Be'er Sheva Quarry can be divided into three types of building stones: "the Station Unit", "the Governor Unit" and "the Byzantine Unit". The natural rock layers are covered by manmade tailing remnants of the Ottoman quarrying works and new filling materials dumped in the northern parts of the quarry (Figure 13).

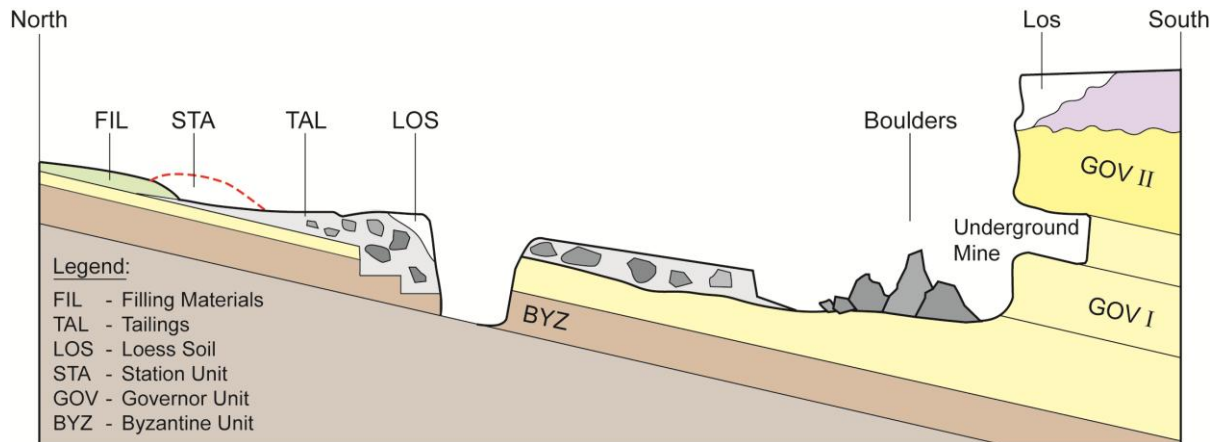


Figure 13: Rock types in the Be'er Sheva Quarry - a schematic cross-section

The following is a short description of the 3 main units:

4.3. STATION UNIT

A brown, hard, coarse grained limestone is exposed in the northwest corner of the quarry. This stone was used intensively during the Ottoman Period in the construction of the Old City of Be'er Sheva. The significant buildings constructed from this stone are the Turkish Train Station complex. There are no remaining reserves of this unit within the quarry borders (Figures 14-15).



Figure 14: The only outcrop of the Station Unit within the quarry



A. Fossil fragments in the natural layers in the quarry



B. Fossil fragments in the building stones in the Turkish station

Figure 15: The characteristics of the Station Unit rocks

4.4. GOVERNOR UNIT

A whitish, soft fine grained, chalky limestone was intensively exploited by the Ottomans. The rocks are composed of microscopic crushed skeletons of sea urchins (Figure 16). The gentle inclination of the layers to the south is named 'clinofolds', meaning sediments which accumulated and consolidated on an existing morphological feature - in this case in the slopes extending from the north bank of the canyon toward its center in the south (Figure 17). Widespread fossil burrows are found at the bottom of a natural layer in the quarry and show up in the building stones in the Old City (Figures 18-19).

The depth of this unit below the quarry floor is as yet unknown. This chalky limestone is sensitive to desert weathering by salty water which slowly disintegrates it over time. The Turkish used this stone to build houses in the Old City, among them Governor House.

The contact between the Station and the Governor Unit is undulating (Figure 20).



Figure 16: Outcrop of the Governor Unit in the southern part of the quarry



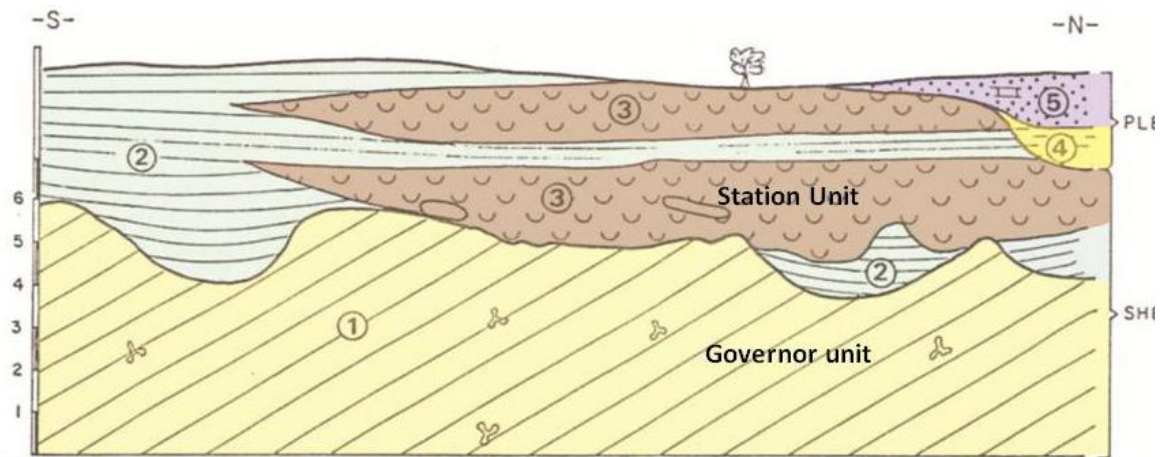
Figure 17: Clinoforms - gentle layers inclination to the south at the west face of the quarry



Figure 18: Fossil burrows at the bottom of a natural layer in the quarry



Figure 19: Fossil burrows at the bottom of a natural layer and in building stones



37 (Source: Buchbinder 1985)



Figure 20: The lentic and undulating shape of the contact between the Station and the Governor Unit

4.5. UNDERGROUND MINE

The cave in the southern face of the Governor Unit was once an underground mine. The boulders at the bottom of the quarry, just below the entrance to the cave, are remnants of the roof of the mine which collapsed (Figures 21-22).



Figure 21: The underground mine in the south face of the quarry



Figure 22a: Entrance to the underground mine and the nearby boulders



Figure 22b: View from the cave: the entrance and a relief drawing

4.6. BYZANTINE UNIT

The lowest exposed unit in the quarry was named the 'Byzantine Unit'. This unit has a limited exposure area. The rocks are composed of fine grained relatively hard gray silty limestone. This unit should be studied further (Figures 23-25).



Figure 23: Overview of the Byzantine mine in the center of the quarry



Figure 24: Mining tools imprint and mining face



Figure 25: The contact between the mining face and the tailing gives the impression that this site was reactivated after tailings were dumped above the mining faces

4.7. LOESS

The desert eolian soil is named loess. This soil layer has limited exposure areas in the quarry. One of the exposures is right above the entrance to the underground mine. In this site the soil fills erosional channels (Figure 25).



Figure 25: Loess exposure above the underground mine

4.8. TAILINGS

The quarry is covered by tailings composed of stone fragments dumped by the users of the quarry (Figures 26-27). There are two questions regarding the tailings:

1. Who dumped the tailings on top of the Byzantine Unit?
2. Who evacuated the tailings from the quarry face?

Was it during the Ottoman Period, or perhaps a long time before this, or perhaps, during the Byzantine Period?



Figure 26: The tailings consist of stone fragments left from mining works



Figure 27: Tailings dumped on top of the mining face

5. IMPRINTS OF OTTOMAN MINING METHODS

The following illustrate the imprints of the Ottoman mining tools (Figure 28)



Figure 28a: Imprints of the mining tools



Figure 28b: Imprints of the mining tools



Figure 28c: Imprints of the mining tools

6. POINTS OF INTEREST

The points of interest are marked in the following map (Figure 29).



Figure 29: Points of interest location map

7. DRILLING CAMPAIGN

7.1. DRILLING SITES AND DEPTHS

In May 2018 Isotype carried out 8 drillings in various areas of the quarry, in specific sites as detailed below (figure 30).

Table: Drilling sites

Drilling site name	Coordinate X	Coordinate Y	Topo elevation	Depth
K1	574575	179956	286	20
K2	574529	179946	286	20
K3	574496	179920	279	10
K4	574397	180006	280	15
K5	574358	179959	270	10
K6	574357	179890	263	15
K7	574337	179889	260	10
K8	574418	179853	267	10

Remark: The topo elevation was determined in accordance with the topographic map. The drills in the northern and eastern areas of the quarry were planned to depths of 15 meters and 20 meters in order to examine, among other things, the thickness of the filling materials. The drillings within the quarry were planned to a depth of 10 meters in order to examine the rock formations from which it may be possible to produce building stones for use in the project.

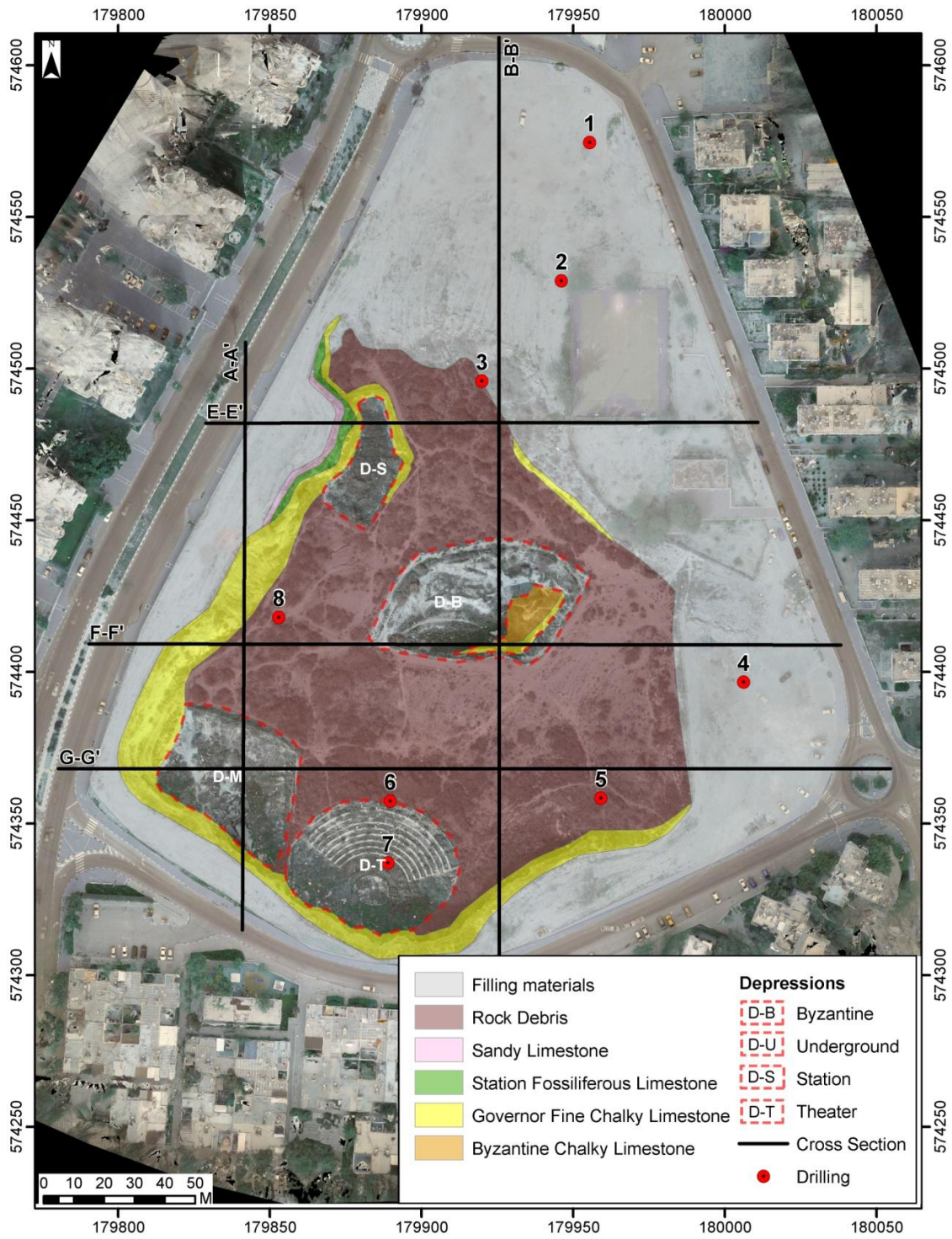


Figure 30: The drilling location upon the geological map of the Turkish quarry

7.2. COLUMNAR DRILLING SECTIONS LITHOLOGICAL UNIT

The section below describes the rock units according to the Isotope Report (Appendix 1), and the photographs of the core boxes (figures 31-47). The drilling data, together with the field survey which was conducted on the site, enables us to present a three-dimensional simulation of the geology of the quarry.

According to the results of the drillings, the subterranean rock can be classified into four units² as specified below (Appendix 1):

Table: Legend for the rock units specified in the columnar sections and in the geological cross sections.

Unit No.	Rock unit	Symbol
I	Filling mat.	F
II	Station	S
III	Governor	G
IV	Byzantine	B

- I. Filling materials unit – filling materials were found in all the drillings. In the quarry most of the filling materials lying on the natural bedrock are rock blocks of various sizes which are the remaining remnants of the quarrying works that were conducted here in the Ottoman period. The other part is filling materials of various types, mainly construction waste and other filling materials which were dumped on the faces of the quarry. Desert soil (loess), which has remained in several places in their natural location, was found in some drillings below the filling materials. The thickest layers of filling materials located in the drillings are between 5.6 meters and 12 meters. However, it is possible that thicker layers of filling materials may be found during the construction works, especially in the northern part of the quarry.

Filling materials have no value and have to be stripped prior to the extraction of the natural stone lying beneath the filling. In addition, in areas where filling materials are found, instructions are needed to ensure that the building foundations will be on natural rock.

- II. Station unit - This unit was found in the K4 drilling, which is located outside the quarry pit between Akiva Street and the eastern face of the quarry. This rock unit is exposed on the western face of the quarry (figure 30). This is a unit of hard brown porous limestone, enriched with fossil remains. This lithological unit is probably a remnant of a reef of shales and other marine creatures which lived on the cliff of the ancient fiord which was here in the geological past. During the rock lithification part of the fossil skeletons were dissolved leaving behind pores. Fractures of less than 50 cm apart cross the layers – this can limit the size of the construction stone which can be

²

The units specified here are the same units which were specified in earlier in the report.

produced from the layers. In the K4 drilling the unit is covered with filling material of 5 meter thickness. The drilling descended to a depth of 15 meters; however, the base of the unit was not reached up to this depth. In accordance with the exposure on the western face of the quarry it seems that the drilling reached close to the base of the unit.

The Ottoman railway station and various houses in the old city of Be'er Sheva were built from stones that were quarried from this unit. As previously mentioned the "Station" unit was located at a drilling in the eastern part of the quarry and is also exposed on the western face of the quarry. It can therefore be assumed that the Station unit which was found in the K4 drilling in the subsurface on the eastern side of the quarry was a continuous part of this unit, which was exposed in the quarrying works on the western face of the quarry. Therefore, the upper part of the quarry pit reflects, to a lesser or greater degree, the volume of stone produced by the Ottomans from this unit.

A summary of the findings in the K4 drilling is presented in figure 31. The stratigraphic position of the Station unit in accordance with the K4 drilling is presented in the FF cross-section in figure 48. The location of the unit on the western face of the quarry is presented in the AA cross-section in figure 48. Polished samples of the unit are presented in diagrams 42 - 45.

- III. Governor unit - This unit was located in the K1 and K2 drillings, outside the quarry in the northern part of the project area, and in the K8 drilling at the foot of the western side of the quarry. This rock unit is exposed on the western and the southern faces of the quarry (figure 30). This is a white limestone unit, relatively hard, which tends to be weathered. The densities of the fractures which cross the layers in this unit vary from place to place throughout the quarry and in the various drillings. Most of the houses in the Ottoman city of Be'er Sheva were built from this unit and from the underlying Byzantine rock unit.

The K1 and K2 drillings were conducted in the northern part of the quarry, in an area covered with filling materials and natural soil with a thickness of approximately 3-5 meters. The thickness of the filling increased from north to south. In the K8 drilling, the unit is covered mainly with materials which had rolled downhill.

The Talus (rock debris) accumulated at the bottom of the western face of the quarry remains in the area from the quarrying work that was conducted here during the Ottoman period. The maximum thickness of the unit is approximately 6 meters and this is found in the K1 drilling. The minimum thickness is 3.5 meters and this is found in the K8 drilling. The transition between the Governor unit and the underlying Byzantine unit is not sharp and gradual. The continuity of the unit throughout the quarry can be reconstructed as shown in the cross-sections.

A summary of the findings in the K1 and K2 drillings in the northern part of the quarry are presented in figure 31. The stratigraphic location of the

Governor unit is marked in each of the cross-sections in figure 48. The polished samples taken from the unit are shown in figure 41.

IV. Byzantine unit – This unit was found in the K1 and W2 drillings outside the quarry, in the northern part of the project area, in the K3 drilling at the foot of the northern face of the quarry pit, in the K5 drilling in the K7 drilling close to the southern wall of the quarry and in the K8 drilling in the western part of the quarry. This rock unit is exposed in the deep quarrying pit in the center of the quarry which probably establishes the quarry floor and is covered with fragments of stones and quarrying debris (figure 31). The unit is a relatively hard yellowish limestone. This limestone also tends to be weathered. The density of the fractures in this unit which cross the layers also varies from place to place throughout the quarry and in the various drillings. Most of the houses in the Ottoman city of Be'er Sheva were built from this unit and from the Governor unit. As mentioned previously, it is difficult to clearly distinguish the stratigraphic boundary between the two units.

A summary of the findings in the drillings in which the unit was found is presented in figure 31. The stratigraphic location of the Byzantine unit is presented in the cross sections in figure 48. Polished samples of the unit are presented in figure 41.

Figure 31: The thickness of the rock units in the drillings, the characterization of the lime and the strength of the stone (a red letter in the fracture level column indicates that the rock is weak or that the fracture is dense and it is not possible to produce rock. A black letter in this column indicates that it is possible to examine the feasibility of producing stone blocks)

K1 drilling

Fracture level	Rock Unit	Unit no	Depth (m)	Polished samples	Cores
F	Fill	I	3.5-0.0		Fig 34
G	Governor	III	10-3.5		
B	Byzantine	IV	20-10	Fig 41	

K2 drilling

Fracture level	Rock Unit	Unit no	Depth (m)	Polished samples	Cores
F	Fill	I	5.1-0.0		Fig 35
G	Governor	III	11.0-5.1		
B	Byzantine	IV	20.0-11.0		

Figure 31: The thickness of the rock units in the drillings, the characterization of the lime and the strength of the stone (a red letter in the fracture level column indicates that the rock is weak or that the fracture is dense and it is not possible to produce rock. A black letter in this column indicates that it is possible to examine the feasibility of producing stone blocks)

K3 drilling

Fracture level	Rock Unit	Unit no	Depth (m)	Polished samples	Cores
F	Fill	I	8.1-0.0		Fig 36
B	Byzantine	IV	10.0-8.1		

K4 drilling

Fracture level	Rock Unit	Unit no	Depth (m)	Polished samples	Cores
F	Fill	I	5.0-0.0		Fig 37
S	Station	II	15.0-5.0	Fig 42-45	

K5 drilling

Fracture level	Rock Unit	Unit no	Depth (m)	Polished samples	Cores
F	Fill	I	5.5-0.0		Fig 38
B	Byzantine	IV	10.0-5.5	Fig 47	

K6 drilling

Fracture level	Rock Unit	Unit no	Depth (m)	Polished samples	Cores
F	Fill	I	12.2-0.0		Fig 39
B	Byzantine	IV	15.0-12.2		

K7 drilling

Fracture level	Rock Unit	Unit no	Depth (m)	Polished samples	Cores
F	Fill	I	6.5-0.0		Fig 40
B	Byzantine	IV	7.5-6.5		
B	Byzantine	IV	10.07.5		

Figure 31: The thickness of the rock units in the drillings, the characterization of the lime and the strength of the stone (a red letter in the fracture level column indicates that the rock is weak or that the fracture is dense and it is not possible to produce rock. A black letter in this column indicates that it is possible to examine the feasibility of producing stone blocks)

K8 drilling

Fracture level	Rock Unit	Unit no	Depth (m)	Polished samples	Cores
F	Fill	I	3.5-0.0		Fig 41
G	Governor	III	6.0-3.5		
B	Byzantine	IV	10.0-6.0		

8. PHOTOGRAPHS OF CORE CASES



Figure 32: Photograph of cores from K1 drilling (from isotope report)



Figure 35: Photograph of cores from K4 drilling (from isotope report)



Figure 36: Photograph of cores from K4 drilling (from isotope report)

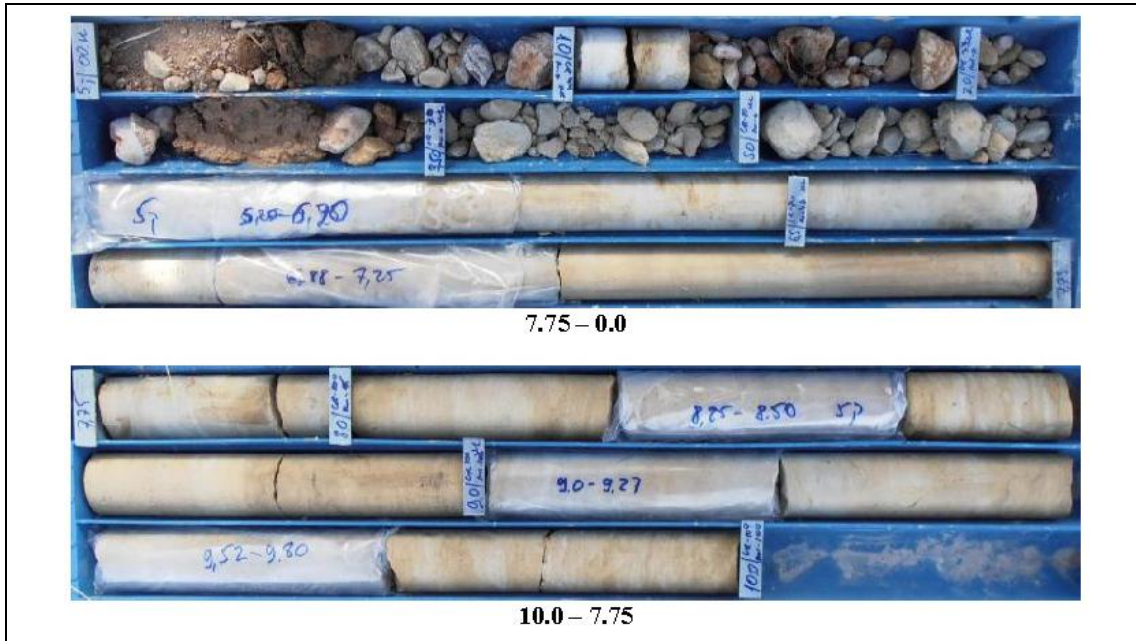


Figure 37: Photograph of cores from K5 drilling (from isotope report)

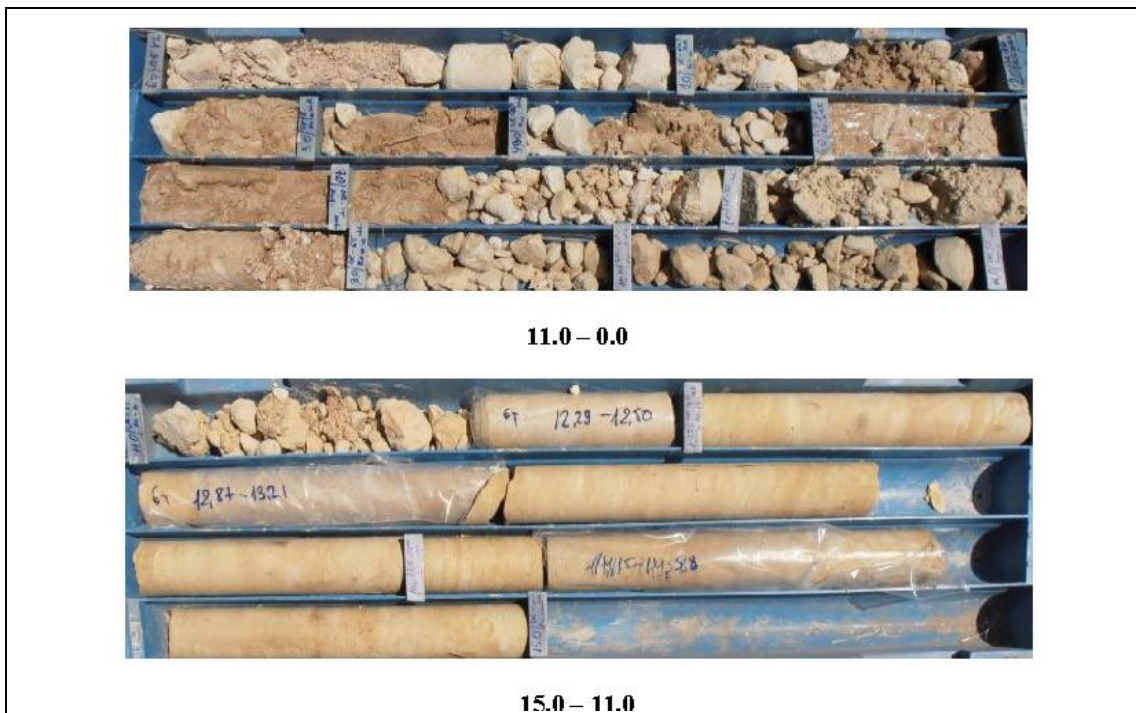


Figure 38: Photograph of cores from K6 drilling (from isotope report)



Figure 39: Photograph of cores from K7 drilling (from isotope report)

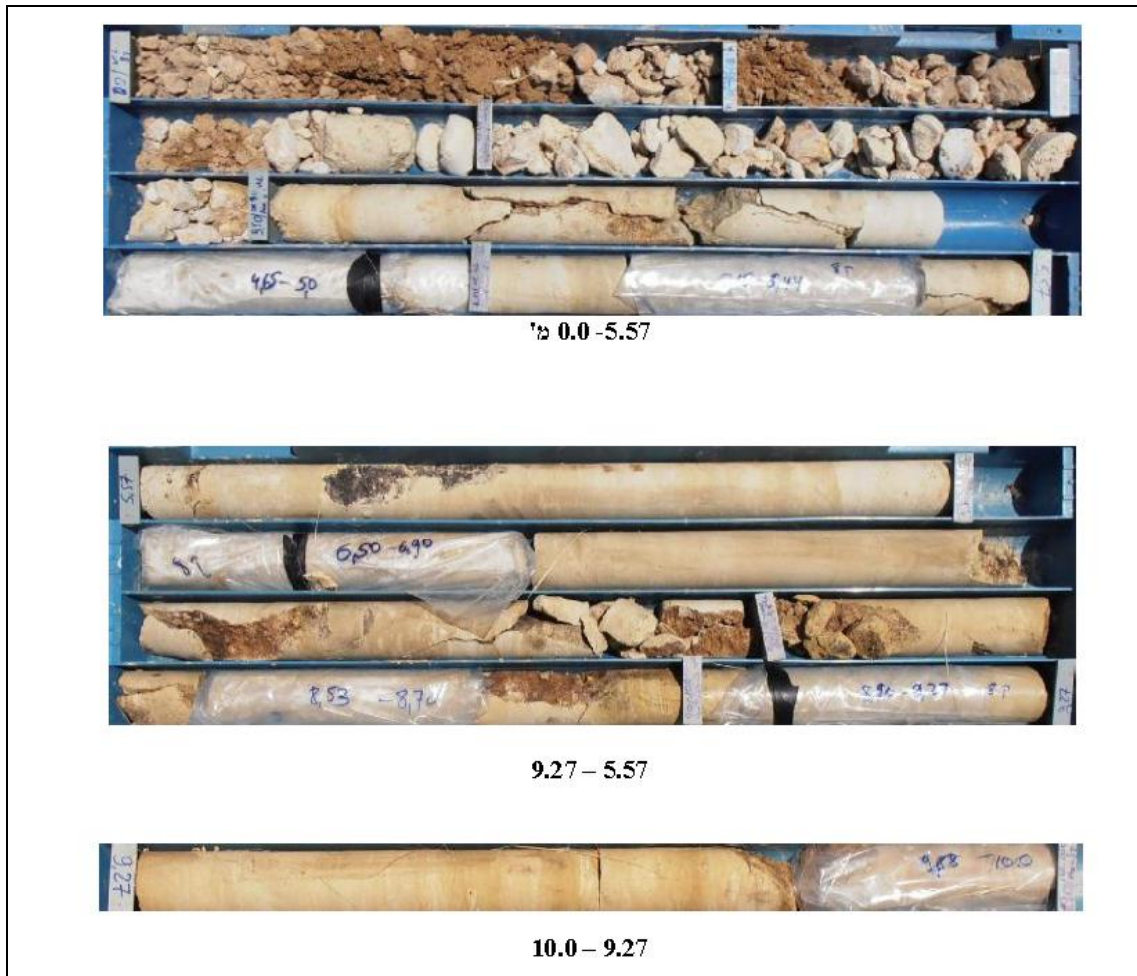


Figure 40: Photograph of cores from K8 drilling (from isotope report)

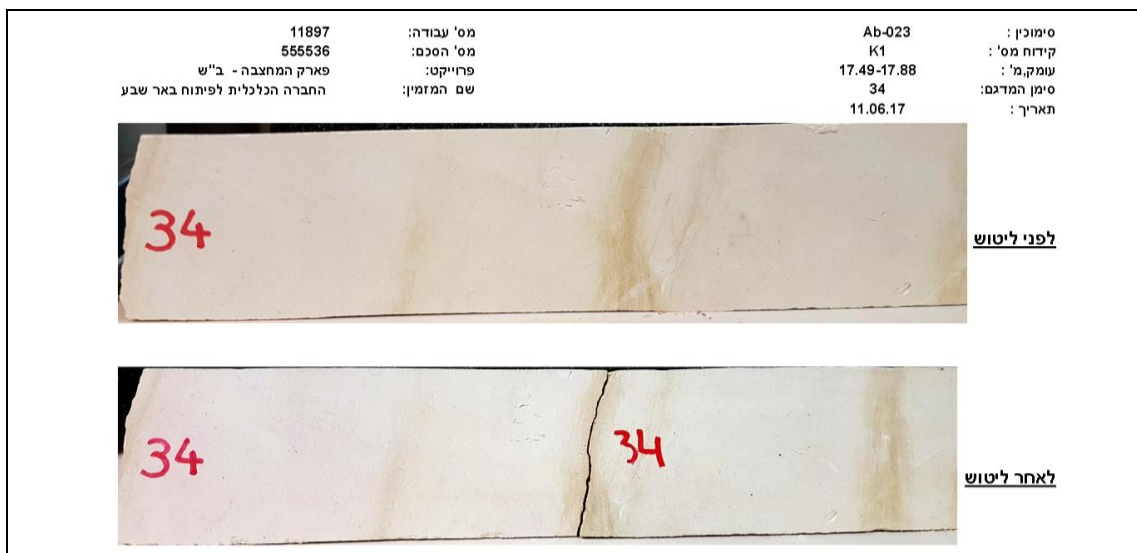


Figure 41: Photograph 34c from K1 drilling (from isotope report)



Figure 42: Photograph of polished sample 30 from K1 drilling (from isotope report)

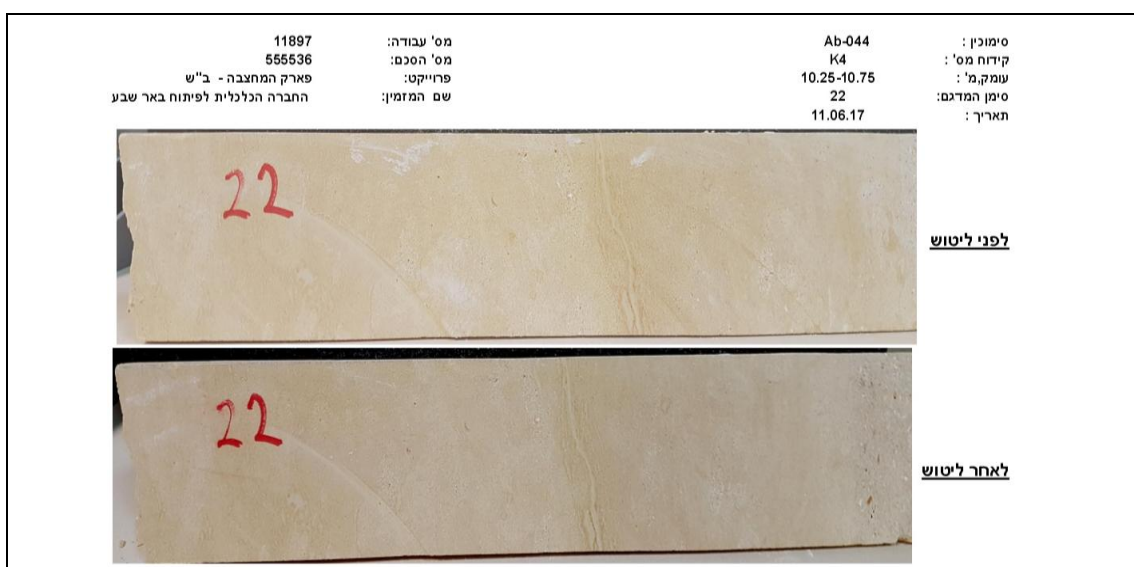


Figure 43: Photograph of polished sample 22 from K4 drilling (from isotope report)

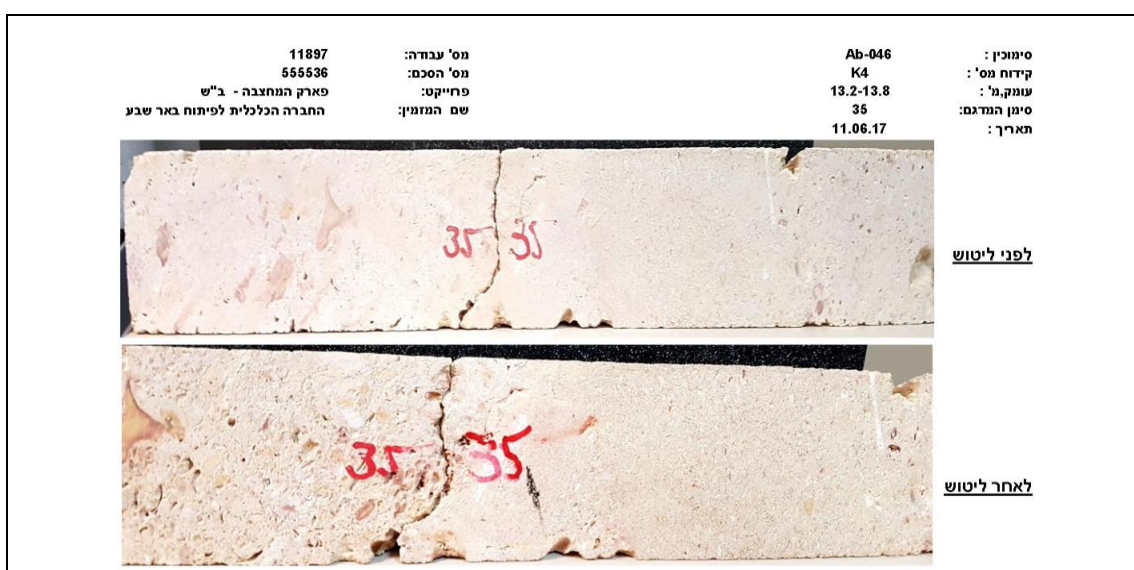


Figure 44: Photograph of polished sample 35 from K4 drilling (from isotope report)



Figure 45: Photograph of polished sample 36 from K4 drilling (from isotope report)

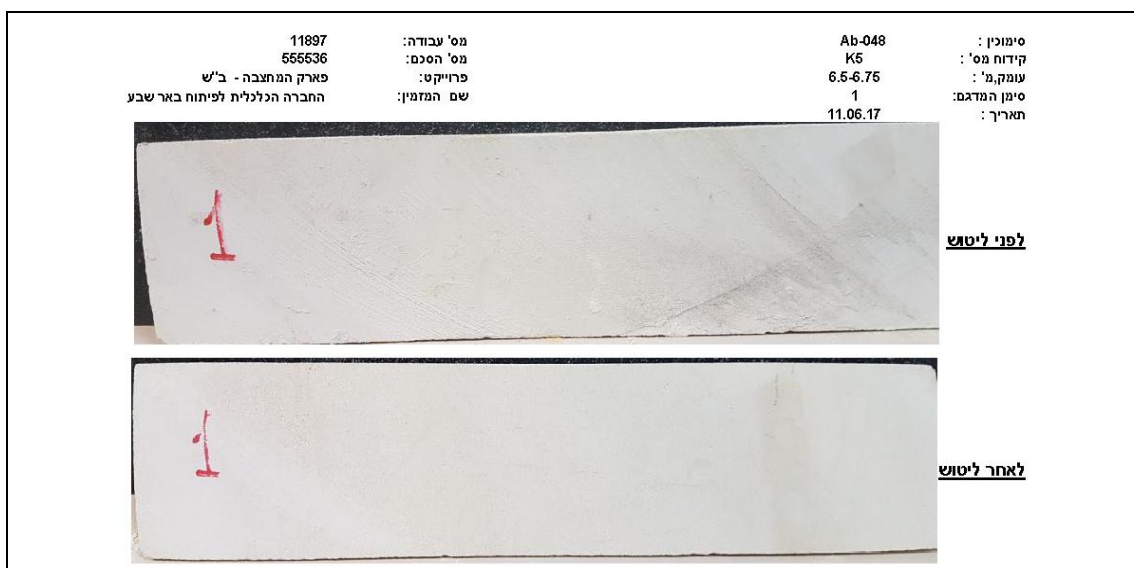


Figure 46: Photograph of polished sample 1 from K5 drilling (from isotope report)



Figure 47: Photograph of polished sample 2 from K2 drilling (from isotope report)

8.1. THE ROCK IN THE QUARRY – CROSS SECTIONS

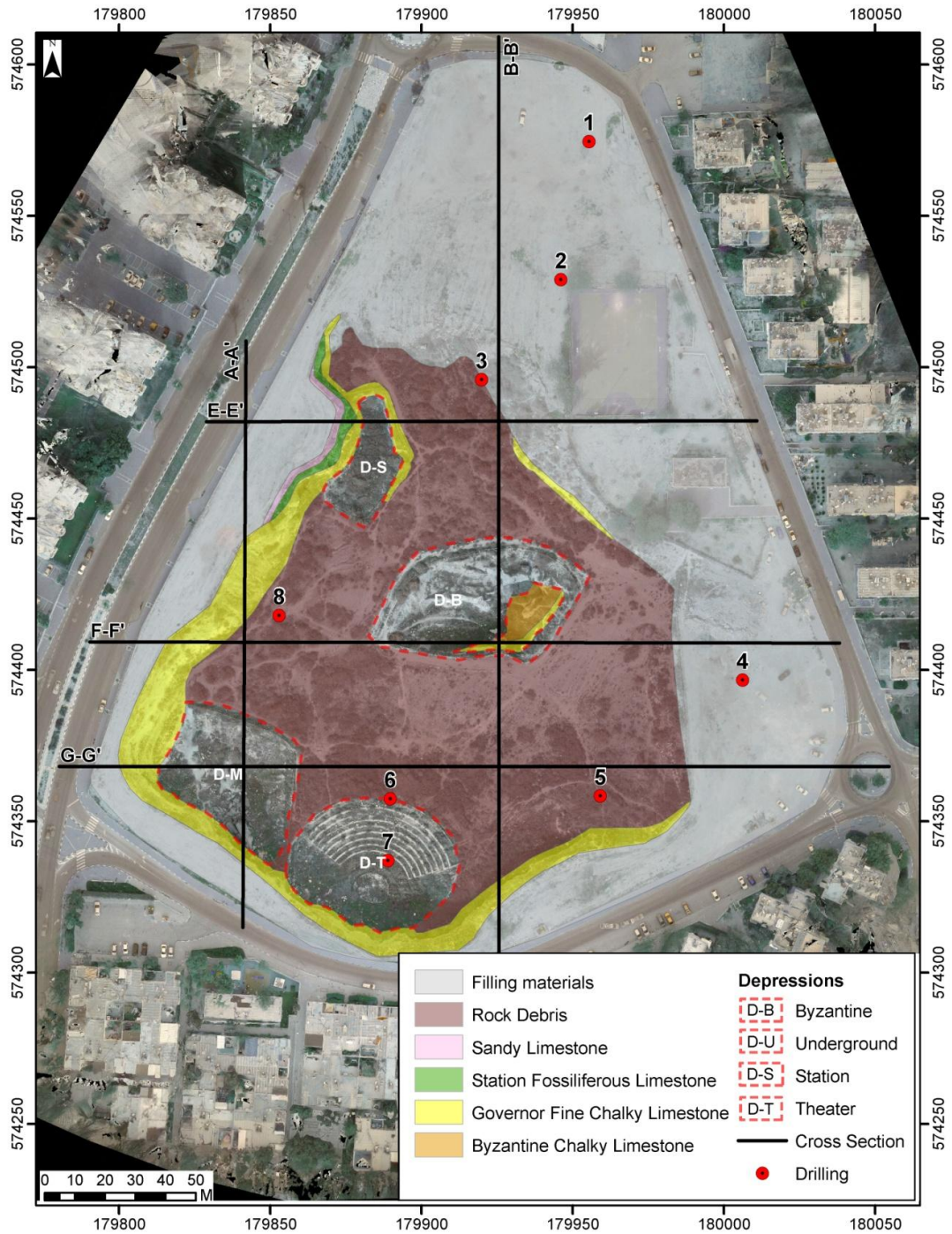


Figure 30A: The drilling locations on a geological map of the Turkish quarry

The following presents the cross sections along the quarry (Figure 48). The locations are shown in Figure 30.

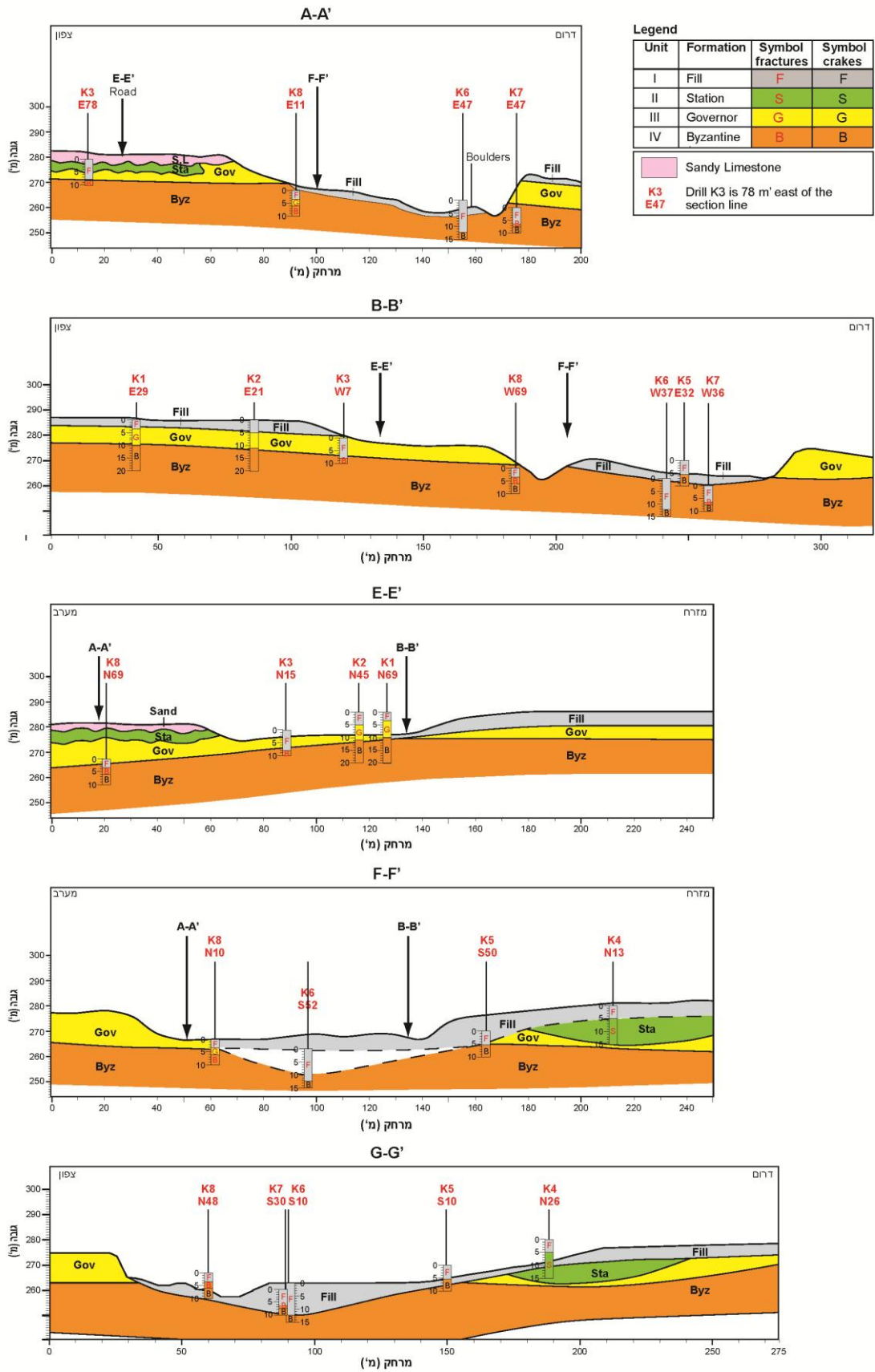


Figure 48: Detailed geological cross-sections

8.2. ADJUSTING THE ROCK FOR BUILDING USES

The main indices for examining the suitability of the local rock to be used as stone for covering buildings are:

- A. Quantity of stone required: estimate of the area / volume of stone which is required to be used, and an examination of whether, in accordance with the results of the drillings, it is possible to produce the stone required for the earthworks program of the project. It is important to note that on an average the economic output volume is estimated to be between 40% and 50% of the volume of the layer found to be suitable in terms of the density of the fractures therein.
- B. Specific gravity weight to rock strength indicator: the specific gravity of the various types of limestone and of porous limestone is relatively low, ranging from 1,800 to 2,045 kg per cubic meter. The absorbency in most samples ranges from 10% to 13%, with a high value of 21.9% and a low value of 7.8%. In accordance with the results of the tests, this is a relatively weak rock. Details of the test results are in Appendix 1.
- C. The possibility of producing blocks: The density of the cracks in the rock in its natural position is an indicator of the size of the blocks. An analysis of the sections in the drilling shows that there are several places throughout the quarry, at different depths, from which stone blocks can be extracted. It is difficult to assess whether it will be possible to produce blocks which are large enough to transfer to a stone sawing plant. In a plant, the stone is sawed with a mechanical saw of the required thickness, and the stone is processed in accordance with the order, mainly sanding or smoothing the face of the stone. The processed stone is sent to the construction site. The production of blocks to be transferred to a sawing plant requires that test quarrying be carried out test to examine whether it is indeed possible to cut blocks of the required size, as well as to check that the stone is durable and will not crumble under the pressure of the mechanical saw. Another option, which seems more reasonable, is to produce the stone with the necessary means and precautions such as a mobile saw, diamond wire and/or other means suitable for the rock in the site, as specified in section 8 below.
- D. Decorative characteristics of the rock: mainly hue and texture. The rock in the quarry belongs to the three units that were produced here during the Ottoman period. The prominent unit is the dark brown limestone of the Station with fossil inlays. The many cavities in the rock are a seal left by melted fossils. The limestone rocks of the Governor unit and the Byzantine unit are gray, beige and yellowish. Some of the samples were polished as part of the drillings (figure 31).

8.3. ADJUSTING THE FOUNDATIONS OF THE BUILDINGS TO THE NATURAL SUBSTRATE

The natural substrate in the area of the quarry is mainly composed of limestone layers with cracks of varying levels. Layers of filling from previous generations, mainly quarrying debris, as well as excavation debris, soil and building debris has accumulated in the areas of the quarry

Specific reference to the condition of the foundation and the investigation required to provide instructions will be provided by the land consultant.

9. ADDITIONAL STEPS

- a) Perform cut and fill calculations, and examine the rock characteristics according to the excavation levels.
- b) Examine the volume of natural rock which can be produced according to the architect plane. If possible recommend changes to the plan in order to produce a larger volume of rock. .
- c) Assess the geological feasibility of stone block production in the quarry in the selected sites:
 - Strip the natural rock in the selected sites
 - Extract 1-2 natural rock blocks and ship to the sawing factory
- d) Apply to the land authority for a rock production license for the use only within the project boundaries
- e) Following the receipt of positive results and license approval - hire a qualified stone producer for building stone production.
- f) The blocks will be shipped to a stone factory for sawing and tile production, or sawed on-site. This will be performed by a qualified stone producer.

10. MINING METHODS

The main methods currently used to mine building blocks are presented below (Figures 49-52)³:

10.1. PERFORATION



A. Drilling holes with mechanical hammers of ~1 m depth and 20 cm from each other



B. Placing long chisels into the drilling holes. Hammering on the chisels till the block is separated from the natural formation



C. A similar method was used during ancient times



D. Storing blocks in the quarry until shipping to the sawmill (AE)

Figure 49: Perforation method for rock block extraction

³ Photographs taken from Stonebtb.com and other internet sites, or from A.E

10.2. ROCK SAW



A. Vertical Saw



B. Roll Disk saw



C. Single disk saw on an excavator



D. Double disk saws on an excavator



E. Trenches of the disc saw immediately prior to rock extraction (AE)

Figure 50: Different rock saws used for rock block extraction

10.3. DIAMOND WIRE SAW



A. Diamond wire saw (type 1)



B. Diamond wire saw (type 2)



C. Entrance to underground mine



D. Mining face of a Diamond wire saw mine

Figure 51: Different types of rock saws used for rock block extraction

10.4. TRANSPORTATION OF MINED BLOCK



Carrying the blocks from the mining face (wall)



Blocks on the trailer (AE)

Figure 52: Transportation of mined blocks

11. ARCHITECTURE OF BUILDING STONES

At the beginning of 20th century, stones from this quarry were used for building most of the houses in the Old City of Be'er Sheva (Figures 53-59).

11.1. FIRST TWO STORY HOUSE



Figure 53: The first two story house in Be'er Sheva, built in 1900-1901 by European architects. In 1914 it was turned into an hotel, in 1917 it served as the headquarters of General Allenby, and in 1948 it hosted the first pharmacy in the Negev

11.2. TURKISH TRAIN STATION



Figure 57: The Turkish train station in Be'er Sheva; The buildings were designed by 2 architects, one from Germany and the other from Switzerland. Today the station has been restored to the highest standards.



Figure 55: Architectural elements in the Turkish train station

11.3. GOVERNOR RESIDENCE AND SHEIKH'S SONS' SCHOOL



Figure 39: Stones from the Governor White Unit were used to build the Governor's House. The house was built in 1906 and served as the Governor Residence until 1938. In 1949 it was converted into the Be'er Sheva City Hall. Today it is part of a museum (the Negev Museum)



Figure 56: The Governor White Unit was the main building-stone used to build one of the most impressive houses in the Old City of Be'er Sheva. It was constructed in 1906 as the school of the Sheikh's sons. In 1916, during World War I, it was used as a hospital. Today it serves as the Natural Museum of Be'er Sheva

11.4. GOVERNOR STONE SENSITIVITY



Figure 57: Building stones from the Governor White Unit are sensitive to desert weathering. Rock disintegration causes severe damage to buildings

12. GROUND WATER

The regional ground water lies at about 200 m below the surface. It should be taken into account that local water table might be found in shallower depths.

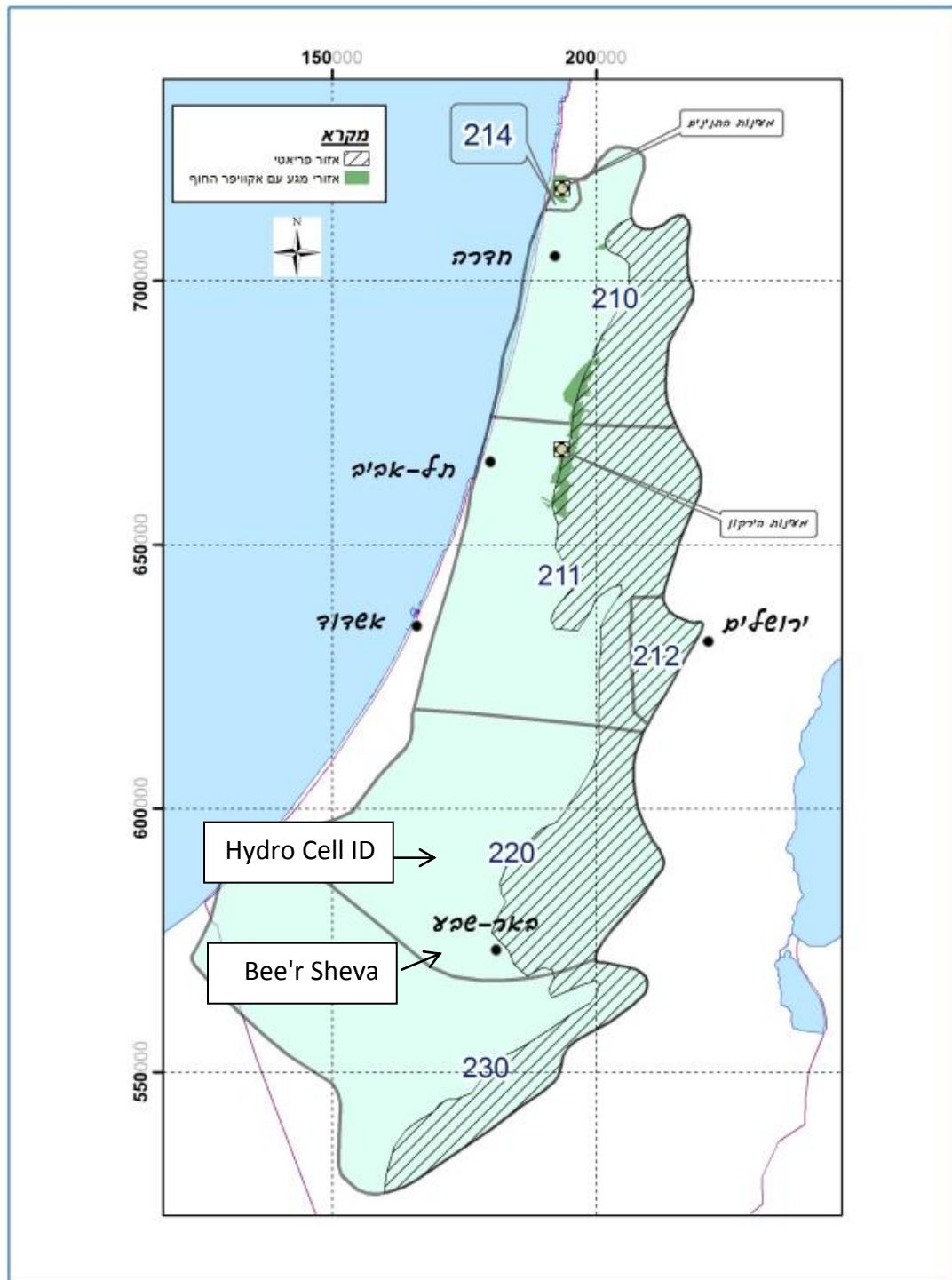


Figure 58: The main aquifers in the area
(Source: Israel Hydrological annual report, 2012)

13. DISCUSSION

13.1. BUILDING BLOCKS FOR QUARRY REHABILITATION

The means used to extract blocks of stone are described above. Utilizing one or more of the different methods should be approved by the authorities. The dimensions of the building blocks are dependent primarily on the rock strength and on the nature of the vertical and horizontal cracks. The building stones in the Old City of Be`er Sheva which were extracted from this quarry have reasonable dimensions.

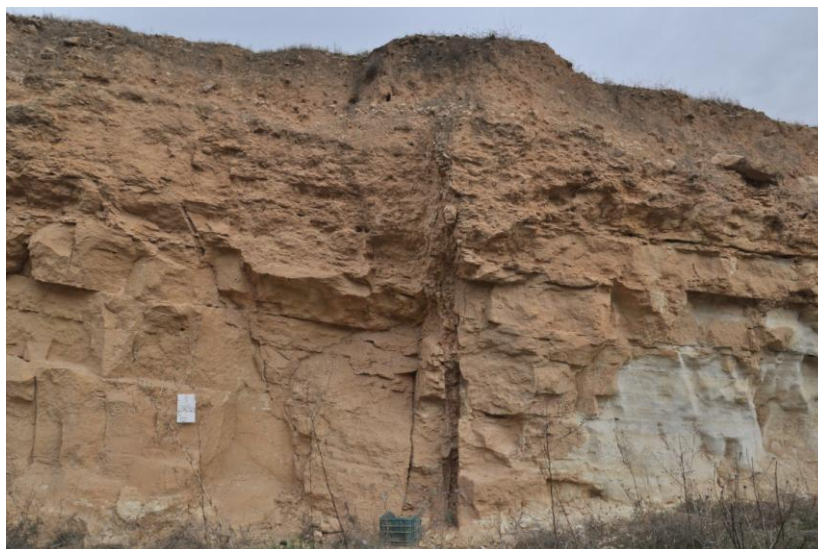


Figure 59: The vertical and horizontal cracks crossing the Governor Unit define the size of the extracted blocks

13.2. STONE BLOCK DIMENSIONS AND USE

The dimensions of mined blocks should be larger than 1 cubic meter. The recovery depends on mining machinery such as drills and chisels, diamond wire or disc saw. The mined blocks are sent to a factory where they are cut into slabs. The main uses of the slabs are for chiseled building stones, tiles for floors and decorative architectural elements.

13.3. PRODUCTION, RECOVERY AND TAILINGS

The recovery of suitable blocks in terms of dimensions and hardness is estimated to be around 40%-60% of the entire quarrying volume. The rest is tailing materials that have no use and should be moved from the quarry to an authorized dumping site.

Assuming an excavation volume of 125,000 cubic meters (50m X 50m X 50 m) and a recovery of 50%, one can expect production of around 60,000 cubic meters, which equals half of the annual consumption of building stone in Israel. However, the demand for this relatively soft stone in the Israeli building sector is unknown. The residual 60,000 cubic meters are of too low quality to be

crushed for use in concrete or paving mixtures. Hence, it seems that this waste material will have to be delivered to an authorized dumping site.

13.4. STONE SUITABILITY FOR THE PROJECT

The Station Unit - This building stone type has been completely exploited and there are no reserves remaining within the quarry borders.

The Governor Unit - This building-stone type is soft and might break apart when using ordinary industrial saws. Perhaps a special delicate saw will manage to cut the rock without damaging it. As can be seen in the buildings in the Old City of Be'er Sheva this stone type is also sensitive to desert weathering. Hence, using this stone for rehabilitation construction will require means of protection.

The Byzantine Unit - This building stone type should be studied in detail for more defining features.

Filling materials and mining tailings cover the bottom of the quarry and its northern area. The thickness and volume of the tailings and of the filling material should be measured throughout the geological investigation.

Remark: At present there is no quarry which produces building stones from these rock formations.

13.5. ENVIRONMENTAL IMPACT

Quarry activity results commonly in dust pollution and noise. In this type of quarry (extracting blocks) the source of dust and noise are tractors, drilling machines, rock saws and trucks. Appropriate means should be taken to minimize environmental impacts.

13.6. ENGINEERING ASPECTS

Berm height, width and sloping angle should be designed according to civil engineer instructions.

It should be mentioned that the foundations of all the buildings in the city of Be'er Sheva are based on such rocks, without any special means or extra support.

13.7. DRAINAGE

The permeability of these rocks depends mainly on the density of small and large fractures that cut through the rock. Rainfall water is drained to lower and closed areas. This should be taken in account.

13.8. VEGETATION TYPE

Vegetation types that can be used in the quarry rehabilitation should either be of desert species, or be supported by an irrigation system.

**דו"ח
סקר גיאוהנדסי**

פרויקט

פארק המחצבה (מחצבה התורקית), באר שבע

הזמנת רכש 175 מתאריך 19.01.17

הוכן עבור:

1. חברת הכלכלית לפיתוח באר שבע,
מנהלת הסכם הגג

באר שבע, שד' יצחק רגר 57, בניין A
לידי: מר עדי קוציה, מנהל תאום שליטה ובקרה

2. רון בנארי, מהנדסי קרקע וביסוס בע"מ

רח' התמר 64, כפר בו נון
לידי: אינג' רון בנארי, יועץ הקרקע

3. גיאולוג עמיר אידלמן

רח' שמעון 5, ירושלים 9362905
לידי: דר' עמיר אידלמן - גיאולוג הפרויקט

מס' עבודה: 11897
מס' הסכם: 555536

27.06.17

תוכן עניינים

מבוא 1

1. לוגים של קידוחי ניסיון כולל תוצאות בדיקות שדה ומעבדה 2

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26.06.17

לכבוד
מר עדי קורציה
מנהל תאום שליטה ובקרה,
מנהלת הסכם הגג
חברת הכלכלית באר שבע

א.נ.,

הנדון: חקירה גיאוהנדסית עבור פרויקט "פארק המחצבה בבאר שבע" - דו"ח 11897

בהתאם להזמנת עבודה של החברה הכלכלית ב"ש (הזמנה מס' 175 מתאריך 19.01.17) ופרוגרמה בדיקות שהתקבלה מד"ר עמיר אידלמן, גיאולוג עבור פרויקט הנ"ל, בוצעה על ידינו חקירה גיאוהנדסית כדלקמן:

א. עבודות שדה

- ביצוע 8 קידוחי ניסיון עד לעומקים 10-20 מ' בטכניקה WIRE LINE לשם קבלת גלעיני הסלע.
- הקידוחים בוצעו ע"י חב' גיאוטכנולוגיה בע"מ בתאריכים 30.04-08.05.17.
- פיקוח גיאולוגי צמוד הכולל תאור שכבות הקרקע והסלע המופיעות בקידוחים, נטילת המדגמים, מיון הסתכלותי והנדסי, הכנת לוגים ודו"ח במשרד.

ב. בדיקות מעבדה

- על סמך סיווג הסלעים ובהתאם להזמנת עבודה אשר התקבלו גיאולוג הפרויקט בתאריך 23.05.17 נמסרו 38 מדגמים שנטלו מהקידוחים ועל כל חציה אחד בוצעו בדיקות צפיפות יבשה וספיגות. תוצאות של בדיקה הנ"ל נתונות בלוגים המצורפים. בנוסף לכך ובהתאם לדרישות גיאולוג הפרויקט על 7 חציות של גלעיני סלע בוצע ליטוש והמדגמים המלוטשים הועברו למשרד של אדריכל אמיר לותן בתאריך 18.06.17.

ג. צוות ביצוע הסקר

אינג' א. דואל - פיקוח על קידוחים.
דרי'ס. שולוב - בדי' מעבדה.

בכבוד רב,
דוד קינסקי,
גיאולוג ראשי

1. לוגים של קידוחי ניסיון כולל תוצאות בדיקות מעבדה ושדה

פארק המחצבה - ב"ש

<p>שם המזמין: החברת הכלכלית לפיתוח באר שבע יועץ קרקע: אינג' רון בנארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכם: 55536/1 קבלן קידוחים: חב' גיאוטכנולוגיה בע"מ</p>	<p>קואורדינטות: X-179956 Y-574575 גובה אבסולוטי: חתר: תאריך: 03.05.17</p>	<p>עומק בפועל: 20 מ שיטת הקדיחה: אוגר מ קידוח גלעין: 0.0-20.0 מ צינור מגן: 0.0-3.0 מ בנטוניט: מ</p>
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**לוג של קידוח K 1
 סימוכין: B-11897-1**

WR WL	אפיון גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילת מדגם/בדיקה מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק, מ
	CR RQD %	טווח ירידה מ								
WR	15 0	0-1.0				מילוי (?) - חול טיני לעיתים מעט חרסיתי חום עם שברים דקים וגסים של אבן חול וקירטון גירי בכמות בין 10-30%			GM	1
WR	10 0	1.0-2.0						2		
WR	8 0	2.0-3.5						3		
WR	55 -	3.5-5.0				קירטון חולי חום בהיר מעט צהבהב, חוזק נמוך, פריך משוכב היטב ולעיתים מרובד, סדוק ובמקומות סדוק מאוד הסדקים בדרך כלל מקביל לשיכוב ומעט אנכיים			3.5	4
WR	90 -	5.0-6.5							5	5
WR	100 30	6.5-8.0				קירטון גירי בז' לבנבן, משוכב היטב לעיתים לסירוגין עם שכבות דקות של חוואר קירטוני אפור בעובי עד 2 ס"מ הסדקים פתוחים תת אנכיים ואלכסוניים בזווית כ-45 מעלות ומעט אופקיים חוזק בינוני עד קשה ונמוך קיבת סדקים			7.0	7
WR	100 60	8.0-9.5							8	8
			2.029	10.6	9.7-9.8				9	9
									9.5	10

541025490 - isotop@isotop.co.il - דוא"ל: 7075091, דירה 2, ת"ד: 99-8697000, למכתבים: ת"ד: 2, דירה 7075091, דוא"ל: isotop@isotop.co.il - 541025490
 (Continued Next Page)
 באר-שבע, דרך נפחא 6, טל: 08-6280193, ירושלים, גבעת שאול, 6/27 מרכז ספיר, טל: 02-6510231
 רחובות, משה יתום 23, טל: 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666, נתניה, גלגלי הפלדה 18, טל: 09-8620838
 קרית-ביאליק, החוששת 36, טל: 04-8766501, ראשון-צ, אל"ף 3, טל: 03-9622918, כרמיאל, הלבונה 20/5, טל: 04-9582824

פארק המחצבה - ב"ש

<p>שם המזמין: החברת הכלכלית לפיתוח באר שבע יועץ קרקע: אינג' רון בנארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכם: 555536/1 קבלן קידוחים: חב' גיאוטכנולוגיה בע"מ</p>	<p>קואורדינטות: X-179956 Y-574575 גובה אבסולוטי: חתר: תאריך: 03.05.17</p>	<p>עומק בפועל: 20 מ שיטת הקדיחה: אוגר מ קידוח גלעין: 0.0-20.0 מ צינור מגן: 0.0-3.0 מ בנטונייט: מ</p>
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**לוג של קידוח K 1
 סימוכין: B-11897-1**

WR WL	אפיון גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילה מדרג/בדיקה מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק מ'	
	CR RQD %	טווח ירידה מ									
WR	100 80	9.5-11.0				קירטון גירי קשה, בז' בהיר קומפקטי, משוכב בעבה, מעט סדוק הסדקים אופקיים ומעט אנכיים, חלקם פתוחים ועם מישורים (כנ"ל בדף הקודם) מצופים בתחמוצות ברזל				11	
WR	100 90	11.0-12.5	1.845	15.8	11.0-11.2						12
WR	100 95	12.5-14.0	1.800	16.4	12.9-13.2						13
WR	100 98	14.0-15.5	1.880	15.1	14.0-14.5						14
WR	100 95	15.5-17.0									15
WR	100 100	17.0-19.0	1.910	13.0	17.49-17.88						16
WR	100 98	19.0-20.0	1.945	12.5	18.4-18.78						17
WR	100 98	19.0-20.0	1.960	13.0	19.12-19.52						18
											19
											20-0 20

החברה מעבדה מרכזת אי"ת כמות הריחוק 20 טל: 08-8697990 למכתבים: ת"ד 2, גדרה 7075901 דוא"ל: isotop@isotop.co.il ח.פ. 514025496
 באר-שבע, דרך הנצח 18, טל: 08-6280193, ירושלים, גבעת שאול, 6/27 מרכז ספיר, טל: 02-6510231
 רחובות, משה יתום 23, טל: 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666 נתניה, גלגלי הפלדה 18, טל: 09-8620838
 קרית ביאליק, החרושת 36 טל: 04-8766501, ראשון לציון, אליהו 4, טל: 03-9622918, כרמיאל, הלבונה 20/5 טל: 04-9582824

פארק המחצבה - ב"ש

<p>שם המזמין: החברת הכלכלית לפיתוח באר שבע יועץ קרקע: אינג' רון בנארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכמ: 555536/1 קבלן קידוחים: חב' גיאוטכנולוגיה בע"מ</p>	<p>קואורדינטות: X-179946 Y-574529 גובה אבסולוטי: חתר: תאריך: 30.04-01.05.17</p>	<p>עומק בפועל: 20 מ שיטת הקדיחה: אוגר מ קידוח גלעין: 0.0-20.0 מ צינור מגן: 0.0-5.0 מ בנטוניט: מ</p>
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**לוג של קידוח K 2
 סימוכין: B-11897-2**

WR WL	אפיון גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילת מדגם/נדיקה מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק מ'
	CR RQD %	טווח ירידה מ								
WR	10 0	0-1.0				מילוי - חול טיני חום עם צורות דקים וגסים ולעיתים אבנים בגודל עד 12 ס"מ גיריים (סה"כ כ-15-5%) ומעט שברים בודדים של פסולת בניה - שברי בטון ופולסטיק		SM		1
WR	10 0	1.0-2.0								2
WR	2 0	2.0-3.0								3
WR	25 0	3.0-4.0				קרקע טבעית(?) - חרסית רזה טינית חומה עם שברים דקים וגסים של אבן חול קרבונטית בכמות עד 30%		CL		3.0
WR	30 0	4.0-5.0								4
WR	85 40	5.0-7.0				אבן גיר מעט קירטונית בגוון לבנבן, משוכבת היטב קירטון צהוב מעט חום, קומפקטי, מעט סדוק לעיתים לסירוגין עם שכבות דקות של אבן גיר קירטונית בגוון אפרפר בהיר בעובי עד 20 ס"מ חוזר בינוני עד נמוך קירבת סדקים הסדקים אופקיים כל 20-30 ס"מ יש מספר סדקים תת אנכיים פתוחים עם מישרים מחוספסים				5.1 5.4
WR	100 75	7.0-8.0								6
WR	100 85	8.0-9.5								7
			1.870	13.6	9.5					9.4
										10

544025496 - ח.פ. isotope@isotope.co.il דוא"ל, 7075901 גזרה, ת"ד 2, 08-8697000 למכתבים, ת"ד 2, גזרה, 7075901 דוא"ל, 02-6510231 טל: 09-8620838 רחובות, משה יתום 23, טל: 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666 נתניה, גלגלי הפלדה 18, טל: 04-9582824 קרית ביאליק, החרושת 36 טל: 04-8766501, ראש"צ, אליהו 5, טל: 03-9622918, כרמיאל, הלבונה 20/5 טל: 04-9582824

פארק המחצבה - ב"ש

שם המזמין: החברת הכלכלית לפיתוח באר שבע יועץ פרקט: איג' רון בארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכם: 555536/1 קבלן קידוחים: חב' גיאוטכנולוגיה בע"מ	קואורדינטות: X-179946 Y-574529 גובה אבסולוטי: חתך: תאריך: 30.04-01.05.17	עומק בפועל: 20 מ שיטת הקדיחה: אוגר מ קידוח גלעין: 0.0-20.0 מ צינור מגן: 0.0-5.0 מ בנטונייט: מ
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**לוג של קידוח K 2
סימוכין: B-11897-2**

WR WL	אפיין גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילת מדגם/בדיקה מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק מ
	CR RQD %	טווח ירידה מ								
WR	100 85	9.5-11.0	1.780	15.9	10.0-10.35	קירטון קשה לעיתים עד קירטון מעט גירי בז' עד מעט צהבהב קומפקטי ומעט סדוק הסדקים בדרך כלל אופקיים כל 50-60 ס"מ ולפעמים עד 10-15 ס"מ יש מספר סדקים בודדים תת אנכיים, פתוחים עם מישורים חלקם מצופים בתחמוצות ברזל (כנ"ל בדף הקודם) חוזק בינוני עד גבוה				11
WR	100 95	1.0-12.5	1.835	15.4	11.0-11.45					12
WR	100 90	2.5-14.0								13
WR	100 95	4.0-15.5								14
WR	100 100	5.5-17.0	1.595	21.9	15.5-16.20					16
WR	100 85	7.0-18.5	1.865	13.4	16.2-17.0					17
WR	100 100	8.5-20.0	1.840	15.7	18.5-19.0					18
WR	100 100		1.835	15.4	19.0-20.0					19
										20-20

החברה והעבודה מרכזת את כוח הירוק 20 טל: 08-9697000 למכתבים ת"ד 2, גזרה 7075001, דוא"ל: isotop@isotop.co.il פ.נ. 511025400
 באר-שבע, ירושלים, גבעת שאול, 6/27 מרכז ספיר, טל: 02-6510231
 רחובות, משה יתום 23, טל: 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666, נתניה, גלגלי הפלדה 18, טל: 09-8620838
 קרית-ביאליק, החרושת 36 טל: 04-8766501, ראש"צ, אליהו 100, טל: 03-9622918, כרמיאל, הלבונה 20/5 טל: 04-9582824

פארק המחצבה - ב"ש

שם המזמין: החברת הכלכלית לפיתוח באר שבע יועץ קרקע: איג' רון בארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכם: 555536/1 קבלן קידוחים: חב' גיאוטכנולוגיה בע"מ	קואורדינטות: X-179920 Y-574496 גובה אבסולוטי: חתך: תאריך: 04.05.17	עומק בפועל: 10 מ שיטת הקדיחה: אוגר מ קידוח גלעין: 0.0-10.0 מ צינור מגן: 0.0-3.0 מ בנטוניט: מ
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לוג של קידוח K 3
סימוכין: B-11897-8

WR WL	אפיון גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילת מדגם/בדיקה מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק מ
	CR RQD %	טווח ירידה מ								
WR	23 0	0-1.0				מילוי - חול טיני חום מעט צהבהב עם שברים דקים וגסים של אבן גיר ואבן חול בכמות עד 30-40%				1
WR	23 0	1.0-2.0			2					
WR	19 0	2.0-3.5			3					
WR	10 0	3.5-5.0			4					
WL	30 0	5.0-6.5				מילוי(?) - חול טיני מעט חרסיתי חום מעט צהבהב עם שברים דקים וגסים, בדרל כלל של אבן גיר בכמות עד 30%		SC-SM/GC-GM	5	
WL	19 0	6.5-8.0			6					
WL	50 17	8.0-9.0				קירטון בז' לבנבן, קשה, משוכב מעט סדוק הסדקים אופקיים כל 20-40 ס"מ, פתוחים עם מישורים מחוספסים הבליה גבוהה סביב סדקים			8	
WL	100 100	9.0-10.0	1.895	12.7	9.43-9.80		9			
			1.880	13.9	9.8-10.0		10			

החברה ומעבדה מרכזת את כלל הדיקות על 08-9697000 למכתבים ת"ד 2, גזרה 7075001, דוא"ר: isotop@isotop.co.il, טל: 02-6510231
 באר-שבע, יזרעאל, 08-6280193, ירושלים, גבעת שאול, 6/27 מרכז ספיר, טל: 02-6510231
 רחובות, משה יתום 23, טל: 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666, נתניה, גלגלי הפלדה 18, טל: 09-8620838
 קרית ביאליק, החרושת 36, טל: 04-8766501, ראש"צ, אילוז 1000, טל: 03-9622918, כרמיאל, הלבונה 20/5, טל: 04-9582824

פארק המחצבה - ב"ש

שם המזמין: החברת הכלכלית לפיתוח באר שבע יעוץ קרקע: אינג' רון בנארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכם: 555536/1 קבלן קידוחים: חב' גיאוטכנולוגיה בע"מ	קואורדינטות: X-180006 Y-574397 גובה אבסולוטי: חתך: תאריך: 01-03.05.17	עומק בפועל: 15 מ שיטת הקדיחה: אוגר מ קידוח גלעין: 0.0-20.0 מ צינור מגן: 0.0-3.0 מ בנטינג: מ
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לוג של קידוח K 4
סימוכין: B-11897-4

WR WL	אפיון גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילת מדגם/בידיקה מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק מ
	CR RQD %	טווח ירידה מ								
WR	80	0-1.0				מילוי- חול טיני מעט חרסיתי חום מעט צהבהב עם שברים דקים וגסים גיריים ושברי פסולת בניה בודדים (בטון) כמות עד 30%	SC-SM/GC-GM			1
WL	20	1.0-2.0				קרקע טבעית(?) - חול טיני חום צהבהב עם שברים דקים וגסים של אבן חול קרבונטית בכמות עד 30%	GM			1.3 2
WL	80	2.0-3.5				אבן חול קרבונטית בגוון בז', בינונית גביש, עשירה בשברי צדפים ולעיתים בעלת מבנה קונגלומרטי בטווח עומקים 2.3-2.8, 4.8-5.0, 5.3-5.6, 7.4-7.7 מטרם לסירוגין עם שכבות של קירטון גירי קומפקטי חוזק בינוני-גבוה ונמוך קירבת סדקים הסדקים תת אופקיים ומעט אנכיים, רובם פתוחים ויש בהם שרידי חול לא מלוכד				2.5 3
WL	100	3.5-5.0	1.735	12.6	3.8-4.3					4
WL	85	5.0-6.5	1.845	9.8	4.3-4.65					5
WL	100	6.5-8.0	1.990	8.8	4.63-5.03					6
WL	100	8.0-9.5	1.910	8.9	5.25-6.0					7
WL	100		1.890	8.6	6.5-7.53					8
WL	100		1.870	10.5	7.53-8.0					9
WL	100		1.855	8.9	8.0-8.4					10
WL	98		1.905	8.6	8.85-9.3					11


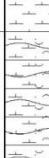


511025490 ש.פ. isetop@isetop.co.il חו"ל: 7075001, גזרה 2, ת"ד 2, למכתב: 08-8697000, טל: 08-6280193, ירושלים, גבעת שאול, 6/27 מרכז ספיר, טל: 02-6510231

באר-שבע, דרך נפחא 6, טל: 08-6280193, נצרת עילית, היצירה 4, טל: 04-6569666 נתניה, גלגלי הפלדה 18, טל: 09-8620838 רחובות, משה יתום 23, טל: 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666 נתניה, גלגלי הפלדה 18, טל: 09-8620838 קרית ביאליק, החרושת 36, ראש"צ, אל"מ 10, טל: 04-8766501, ראש"צ, אל"מ 10, טל: 04-9582824

פארק המחצבה - ב"ש

<p>עומק בפועל: 15 מ שיטת הקדחה: אוגר מ קידוח גלעין: 0.0-20.0 מ צינור מג: 0.0-3.0 מ בנטיט: מ</p>	<p>קואורדינטות: X-180006 Y-574397 גובה אבסולוטי: חתך: תאריך: 01-03.05.17</p>	<p>שם המזמין: החברת הכלכלית לפיתוח באר שבע יועץ קרקע: אינג' רון בנארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכם: 555536/1 קבלן קידוחים: חב' גיאוטכנולוגיה בע"מ</p>
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**לוג של קידוח K 4
סימוכין: B-11897-4**

WR WL	אפיון גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילת מדגם/בידוק מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק מ
	CR RQD %	טווח ירידה מ								
WL	100 98	9.5-11.0	2.045	8.8	10.25-10.75	קירטון גירי בז' צהבהב, קומפקטי חוזק בינוני עד קשה				10.4 11
WL	100 100	11.0-12.5	1.995	9.7	11.0-11.51	אבן חול קרבוניטית בגוון בז', בינונית גביש, עשירה בשברי צדפים ולעיתים בעלת מבנה קונגלומרטי בליה בינונית, חוזק בינוני-גבוה				12.0 12 13 13.8
WL	100 100	12.5-14.0	2.000	9.5	13.2-13.8	קירטון גירי בז' צהבהב, קומפקטי חוזק בינוני עד קשה				14 14.4 15
WL	100 100	14.0-15.0	2.065	7.8	14.0-14.69	אבן חול קרבוניטית בגוון בז', דקת גביש, עשירה בשברי צדפים ולעיתים בעלת מבנה קונגלומרטי בליה בינונית				15
						סוף הקידוח - 15 מ				

המלחה ומעברה מרכזית א"ת כמות חריק 20, טל: 08-8697000, למכתב ת"ד 2, גזרה 7075001, דוא"ל: isotop@isotop.co.il, טל: 02-6510231, 02-6510231
באר-שבע, דרך נפחא 6, טל: 08-6280193, ירושלים, גבעת שאול, 6/27 מרכז ספיר, טל: 09-8620838, רחובות, משה יתום 23, טל: 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666, נתניה, גלגלי הפלדה 18, טל: 04-9582824, קרית ביאליק, החרושת 36, טל: 04-8766501, ראש"צ, אלון ארבעה עשר, טל: 03-9622918, כרמיאל, הלבונה 20/5, טל: 04-9582824

פארק המחצבה - ב"ש

<p>עומק בפועל: 10 מ שיטת הקדיחה: אוגר מ קידוח גלעין: 0.0-10.0 מ צינור מגן: 0.0-3.0 מ בנטינג: מ</p>	<p>קואורדינטות: X-179959 Y-574658 גובה אבסולוטי: חתך: תאריך: 08.05.17</p>	<p>שם המזמין: החברת הכלכלית לפיתוח באר שבע יועץ קרקע: אינג' רון בנארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכם: 555536/1 קבלן קידוחים: חב' גיאוטכנולוגיה בע"מ</p>
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**לוג של קידוח K 5
סימוכין: B-11897-5**



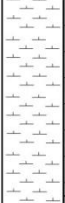

WR WL	אפיין גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילת מדגם/בידיקה מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק מ
	CR RQD %	טווח ירידה מ								
WR	44 0	0-1				מילוי - חרסית רזה חומה בהירה עם צורות דקים וגסים גיריים וקירטוניים ומעט בכמות בין 20-30% בעומק 3.0 מטר נתגלו שרידי ניילון		CL/GC		1
WR	37 0	1-2								2
WR	30 0	2-3.5								3
WL	20 0	3.5-5				מילוי(?) - חול טיני מעט חרסיתי חום מעט צהבהב עם שברים דקים וגסים, בדרל כלל של אבן גיר בכמות עד 30%		SC-SM/GC-GM		3.5 4
WL	70 46	5-6.5	1.845	14.2	6.5-6.75	קירטון גירי לעיתים מעט חולי בז' לבנבן, קשה, קומפקטי משוכב בעבה, מעט סדוק הסדקים בדרך כלל תת אופקיים כל 40-50 ס"מ ומעט אנכיים חוזק קשה				5 5.8
WL	100 95	6.5-8.0	1.860	13.4	7.25-7.75					7
WL	100 100	8.0-9.0								8
WL	100 100	9.0-10.0								9
										10.0

החברה והעבודה מרכזת את כל המידע הנדרש על ידי הלקוח, לרבות: ת"ד גזרה 7075001, חו"ל: isetop@isetop.co.il, טל: 09-8620838, 02-6510231, 08-9365065, 08-6280193, ירושלים, גבעת שאול, 6/27 מרכז ספיר, טל: 09-8620838, 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666, נתניה, גלגלי הפלדה 18, טל: 09-8620838, קרית ביאליק, החרושת 36, טל: 04-8766501, ראשון לציון, אילן 10, טל: 03-9622918, כרמיאל, הלבונה 20/5, טל: 04-9582824

פארק המחצבה - ב"ש

<p>עומק בפועל: 15 מ שיטת הקדיחה: אוגר מ קידוח גלעין: 0.0-15.0 מ צינור מגן: 0.0-3.0 מ בטוויט: מ</p>	<p>קואורדינטות: X-179890 Y-574357 גובה אבסולוטי: חתך: תאריך: 07.05.17</p>	<p>שם המזמין: החברת הכלכלית לפיתוח באר שבע יועץ קרקע: אינג' רון בנארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכם: 555536/1 קבלן קידוחים: חב' גיאטכנולוגיה בע"מ</p>
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**לוג של קידוח K 6
סימוכין: B-11897-6**

WR WL	אפיון גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילת מדגם/בדיקה מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק מ'
	CR RQD %	טווח ירידה מ								
WL	38 0	0.0-11.0				מילוי(?) - צרורות דקים וגסים גיריים וקירטוניים, לעיתים אבנים בודדות בגודל עד 12 ס"מ עם חול טיני ומעט חרסית ביניהם (כ"ל בדף הקודם) כמות הצרורות משתנה מ-30 ועד 70%				11
WL	40 14	1.0-12.5								12
WL	100 98	2.5-14.0	1.845	14.2	13.4-13.7	קירטון גירי בז' מעט צהבהב, קשה, קומפקטי משוכב, מעט סדוק הסדקים בדרך כלל תת אופקיים כל 20-40 ס"מ חוזק קשה				12.2 13 14
WL	100 100	4.0-15.0								15
						סוף הקידוח - 15 מ				

החברה ומעבדה מרכזת א"ת כמות, חירוק 20, טל: 08-8697090, למכתבים: ת"ד 2, גזרה 7075001, דוא"ל: isotop@isotop.co.il, פ.ח. 514025496
באר-שבע, דרך נפחא 6, טל: 08-6280193, ירושלים, גבעת שאול, 6/27 מרכז ספיר, טל: 02-6510231, רחובות, משה יתום 23, טל: 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666, נתניה, גלגלי הפלדה 18, טל: 09-8620838, קרית-ביאליק, החרושת 36 טל: 04-8766501, ראש"צ, אלה 14, טל: 03-9622918, כרמיאל, הלבונה 20/5 טל: 04-9582824

פארק המחצבה - ב"ש

שם המדמין: החברת הכלכלית לפיתוח באר שבע יועץ קרקע: איג' רון בנארי, גיאולוג עמיר אידלמן מס' פרויקט: 11897 מס' הסכם: 555536/1 קבלן קידוחים: חב' גיאוסטכנולוגיה בע"מ	קואורדינטות: X-179853 Y-574337 גובה אבסולוטי: חתך: תאריך: 04.05.17	עומק בפועל: 10 מ שיטת הקדיחה: אוגר מ קידוח גלעין: 0.0-10.0 מ צינור מגן: 0.0-3.0 מ בנטוניט: מ
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לוג של קידוח K 8
סימוכין: B-11897-3

WR WL	אפיון גלעין		משקל סגולי ק"ג/מ"ק	ספיגות %	עומק נטילת מדגם/בידוק מ	תאור שכבה	מיון USCS AASHTO	מיון USCS	לוג גרפי	עומק מ'
	CR RQD %	טווח ירידה מ								
WR 0	70 0	0-1.0				מילוי - חול טיני מעט חרסיתי חום מעט צהבהב עם שברים דקים וגסים של אבן גיר ואבן חול בכמות עד 20-30% נתגלו גם אבנים בודדות בגודל עד 10-12 ס"מ				1
WR 0	34 0	1.0-2.0						SC-SM/GC-GM		2
WR 0	46 0	2.0-2.8								3
WL 0	90 0	2.8-3.5								3.5
WL 32	73	3.5-5.0	1.810	15.2	4.65-5.0	קירטון גירי קשה, בז' אפרפר סדוק מאוד וחלקי מרוסק הסדקים תת אנכיים, פתוחים עם מישורים מצופים בתחמוצות מנגן וברזל				4
WL 69	95	5.0-6.5	1.895	12.7	5.15-5.44					5
WL 57	100	6.5-8.0	1.845	14.0	6.0-6.5	קירטון גירי בז', קשה וקומפקטי הסדקים בודדים וסגורים				6
WL 51	95	8.0-8.9	1.800	15.3	6.95-7.5	קירטון גירי קשה, בז' אפרפר סדוק מאוד וחלקי מרוסק הסדקים תת אנכיים ומעט אופקיים, פתוחים עם מישורים מצופים בתחמוצות ברזל				7.4
WL 84	100	8.9-10.0				קירטון גירי בז', קשה וקומפקטי ומעט סדוק הסדקים בודדים אלכסוניים				8.9
										10.0

המחצבה והמבנה מוכרת א"ת כמות חרוט 20 טון 08-8697099 למכתבים ת"ד 2, גזרה 7075901, דוא"ל: isotop@isotop.co.il, טל: 514025496
 באר-שבע, יו"ר הנפה א"ש טל: 08-6280193, ירושלים, גבעת שאול, 6/27 מרכז ספיר, טל: 02-6510231, רחובות, משה יתום 23, טל: 08-9365065, נצרת עילית, היצירה 4, טל: 04-6569666 נתניה, גלגלי הפלדה 18, טל: 09-8620838
 קרית-ביאליק, החורשת 36 טל: 04-8766501, ראשון לציון, אלון אברהם, טל: 03-9622918, כרמיאל, הלבונה 20/5 טל: 04-9582824

**2. ריכוז תוצאות בדיקות מעבדה
(ספיגות וצפיפות יבשה)**

REPORT

**Absorption and Dry Density of Dimension Stone
ASTM C 97**

סימוכין : Ab-019 - Ab-056
 מס' עבודה: 11897
 מס' הסכם: 555536
 פרויקט: פארק המחצבה - ב"ש
 שם המזמין: החברה הכלכלית לפיתוח באר שבע
 תאריך: 11.06.17

סימוכין	קידוח מס'	עומק, מי	מס' המדגם מסומן	צפיפות יבשה, ק"ג/מ"ק	ספיגות, %
Ab-019	K1	9.7-9.8	20	2.029	10.6
Ab-020	K1	11.0	16	1.845	15.8
Ab-021	K1	12.9	17	1.800	16.4
Ab-022	K1	14.0-14.5	18	1.880	15.1
Ab-023	K1	17.49-17.88	34	1.910	13.0
Ab-024	K1	18.4-18.78	3	1.945	12.5
Ab-025	K1	19.12-19.52	5	1.960	13.0
Ab-026	K2	9.5	?	1.870	13.6
Ab-027	K2	10.0-10.35	10	1.780	15.9
Ab-028	K2	11.0-11.45	11	1.835	15.4
Ab-029	K2	15.5-16.2	13	1.595	21.9
Ab-030	K2	16.2-17.0	14	1.865	13.4
Ab-031	K2	18.5-19.0	15	1.840	15.7
Ab-032	K2	19.0-20.0	12	1.825	15.4
Ab-033	K3	9.43-9.8	?	1.895	12.7
Ab-034	K3	9.8-10.0	?	1.880	13.9
Ab-035	K3	10.0-10.35	?	1.910	12.1
Ab-036	K4	3.8-4.3	24	1.735	12.6
Ab-037	K4	4.3-4.63	26	1.845	9.8
Ab-038	K4	4.63-5.03	25	1.990	8.8
Ab-039	K4	5.25-6.5	29	1.910	8.9
Ab-040	K4	6.5-7.53	30	1.890	8.6
Ab-041	K4	7.53-8.0	31	1.875	10.5
Ab-042	K4	8.0-8.4	32	1.855	8.9
Ab-043	K4	8.85-9.3	21	1.905	8.6
Ab-044	K4	10.25-10.75	22	2.045	8.8
Ab-045	K4	11.0-11.51	23	1.995	9.7
Ab-046	K4	13.2-13.8	35	2.000	9.5
Ab-047	K4	14.0-14.69	36	2.065	7.8
Ab-048	K5	6.5-6.75	1	1.845	14.2
Ab-049	K5	7.25-7.75	2	1.860	13.4
Ab-050	K6	13.4-13.7	4	1.845	14.2
Ab-051	K7	8.0-8.7	7	1.860	13.4
Ab-052	K7	9.2-9.7	8	1.815	14.9
Ab-053	K8	4.65-5.0	?	1.810	15.2
Ab-054	K8	5.15-5.44	?	1.895	12.7
Ab-055	K8	6.0-6.5	37	1.845	14.0
Ab-056	K8	6.95-7.5	38	1.800	15.3

Soil Eng. : S.Shulov, B.Naftaliev