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Military Prediction of Incursion from Underground

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Abstract:

Asymmetric and underground warfare are of very tight relation. The absolute superiority of the coalition forces on the ground and air makes the underground space an additional tricky battlefield. The risk to be buried in the improvised tunnels or shafts is high but acceptable for the enemy, whose survivability on the surface is low. When enemy decides to make use of the underground space for his benefit, the coalition forces have to predict the location of underground openings. There are existing and recently excavated drifts. The first ones could be created by nature or dug by people. The enemy can utilize them as dugouts, assembly or logistic points. The recently excavated drifts could be utilized by the same way or offensively. Cave outlets could be used as firing points. No coalition facility can be safe against undermining. The article would like to explain the geotechnical conditions that can facilitate or hamper the enemy's effort to make use of the underground space.

Keywords:

Underground Drifts, Caves, Undermine, Perimeter Security.

1. Introduction

The recently ruling doctrines emphasize the manoeuvrability and shade the underground warfare. Although the undermining warfare, siege of the fortresses has been an integral part of military activities for millennia, the manoeuvre warfare excluded this static nature from its regulations. On the other hand, 20th century brought many facts of successful guerrilla warfare, when saps facilitated defensive and even offensive guerrilla operations against strongly protected military facilities. The recently gained experience from Afghanistan emphasized the tendency of the enemy to make use of any option to cover their activities under ground. They prefer existing cavities or they combine them with supplemental openings. The article will focus on the existing cavities notwithstanding of natural or artificial origin, but cannot ignore

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the tactical aspects of the subsoil conditions, which facilitate to undermine the perimeter of any military facility.

2. Existing Cavities of the Natural Origin

The natural formations have acted as hideouts for millennia. People used any overhangs, crevices or caves for their homes. The same should be done by insurgents. Those formations still constitute a significant part of the protective features of the terrain.

2.1. Natural Cavities Originated Mechanically

Fig. 1 shows the example of how the running water and rock fall constitute an excellent dugout. The fracture of the originally homogenous rock was eroded by the running water and a deep narrow crevice occurs. The block falling from top covers it as a roof. The bottom may be filled by sand, boulders or other kinds of detritus. The crevice may be passable for men; some of them may be passable for vehicles.

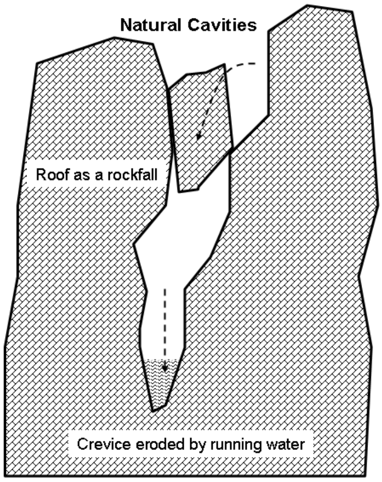

Fig. 1: Natural cavities originated by external process

2.2. Natural Cavities Originated Chemically – Karst Formation

Karst formation is full of underground caves. Limestone as rock can be corroded by water containing carbon dioxide. The running water used the cracks inside limestone and opened them. The originally homogenous rock is perforated by underground streams, creeks or even by rivers [1]. Fig. 2 shows the basic shapes of karst formation. Sink holes (marked "a" in Fig. 2) are very significant formation visible on surface. They are of conical shape and are usually filled by detritus. They are used as small and separated rural lots in agriculturally non-productive karst terrain. Caverns open rock massive to the air like shafts (marked "b" in Fig. 2). Their cross-section varies in about tens of meters. They are used as hideout randomly because of problematic access from surface through subvertical walls. Valleys in the karst are formed by interconnection of caverns (marked "c" in Fig. 2). Caves are subhorizonal openings inside limestone massif. Their direction conforms to the tectonic disturbances in the massif. The whole karst system can predispose a complicated network of the underground caves. If not flooded by rainstorms, they could function as the reliable and resistant dugouts. Their outlets to valley could act as covered entrances or as firing posts against ground or air forces [2]. It depends on the width of valleys.

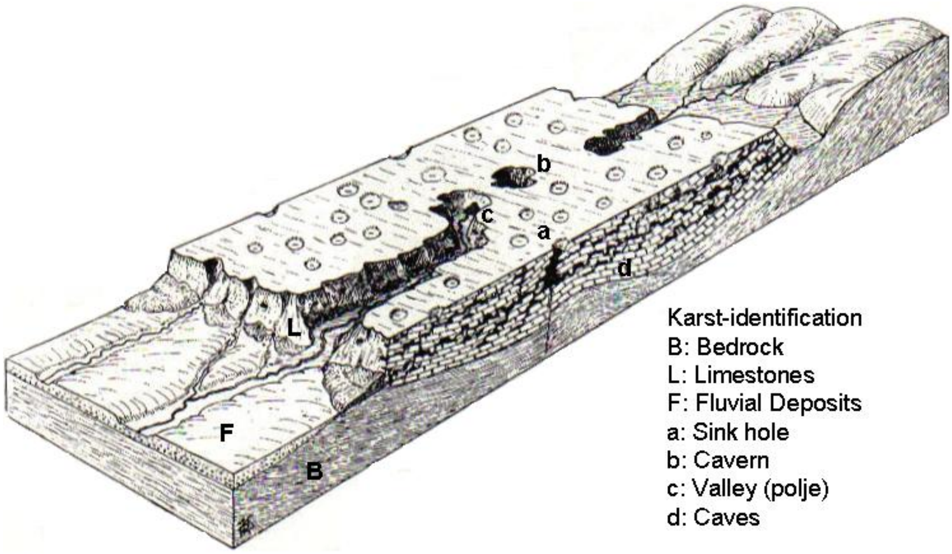

Fig. 2 Identification of karst formations [1]

3. Existing Cavities of Man-Made Origin

There are immense quantity of cavities namely in urban areas. Sewage, collectors, etc. should be inspected regularly while leading under a military facility. There is an evidence of the sewage utilization for robbery. Despite the accessible underground infrastructure in urban area, the attempts to use it to undermine military facility are not recorded. But each commander should be aware of the possibility to misuse those utilities for treacherous incursion into military premises.

3.1. Formation of Underground Cavities in Rural Areas

Rural areas are not characterized by high number of underground utilities. A significant exemption is represented by Karez water distribution system [2]. This is a typical Afghan phenomenon allegedly witnessed in Alexander the Great era. Fig. 3 shows its idealized configuration. Precipitation water accumulated in the mountainous areas flows on the base rocks deeply under deposits. Sub mountainous plains belong to arid area where agriculture depends on irrigation. The sub-horizontal aqueducts excavated towards mountains drain the groundwater directly to inhabited areas. The length of aqueducts should reach tens of kilometres. The vertical wells function as a ventilation system and water source for households. Clean-outs are located near dwellings; outlets are located just at cultivated soil. This system is an excellent site for adaption of the both, aqueducts or wells, for guerrilla facilities. Soviets and Americans described their experience with clearance operations in this environment [3].

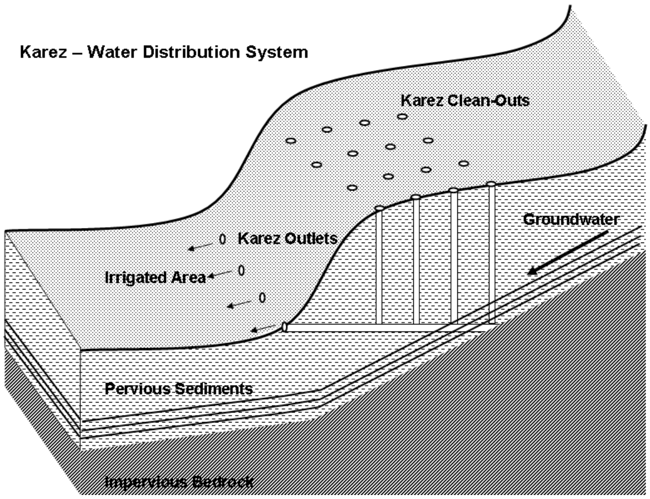

Fig. 3: Principle of Karez System

3.2. Formation of Underground Cavities in Worked Out Mineral Deposits

The mineral deposits have been of social interest for centuries. Copper, tin, zinc, silver, iron, and not gemstones were excavated from underground. The ancient or medieval miners could not dig very deeply in comparison with recent technologies [4]. They had to make use of primitive tools. They tried to extract valuable minerals only without refractory ores. The drainage of stopes was crucial. Flooding of underground openings resulted in abandoning of mines. Very complicated system of heading, inclined drifts or shafts remains until recently.

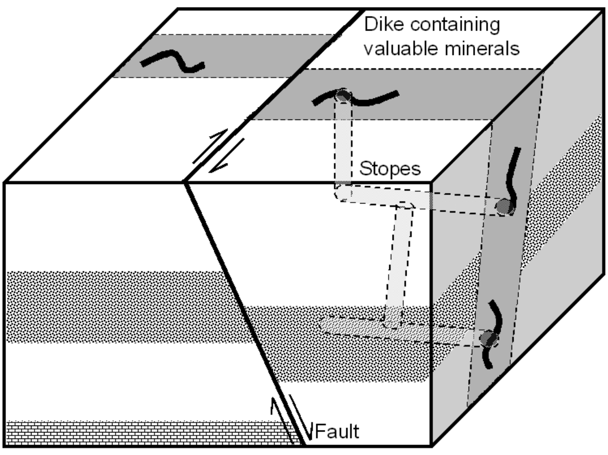

Fig. 4: System of Abandoned Stopes

This situation is shown in Fig. 4. The present status of those drifts cannot be safe for any user. Rotten reinforcement, if any, unpredictable system of openings, partly flooded. Rockfalls have to be expected. Ventilation cannot be expectable. Methane or carbon dioxide could be trapped locally. But those factors provide an excellent protection against incursion. That is why the abandoned mining stopes attract the guerilla fighters, who consider them as an excellent hideout despite the described risk.

3.3. Surface Symptoms of Existing Cavities

Surface entrance of underground opening represents a reliable de-camouflage symptom. So the mentioned Karez system cannot be camouflaged. It is visible from both the ground and air easily. Coalition forces should keep in their mind that people who are capable to build and keep this system functional are capable to adapt it for guerrilla warfare accordingly.

The abandoned drifts could be identified similarly like karst structures. Sinkholes could indicate a cavity underground. But the identification based on the outlets cannot be sufficient. The entrances could be camouflaged easily. Sometimes the trails leading to the entrances could be identified. Another option is to disclose a new pile of soil while a new tunnel is excavated. The permanent observation from the surface and air is of high importance.

Applied geophysics could help in this matter [5]. In the case of the karst or mining excavations, the cavities are developed along tectonic structures like fissures, dikes, faults etc. These structures are filled by liquefied argillaceous material, in the case of ore veins by metallic minerals. The electric prospection could indicate those structures as local conducting lines.

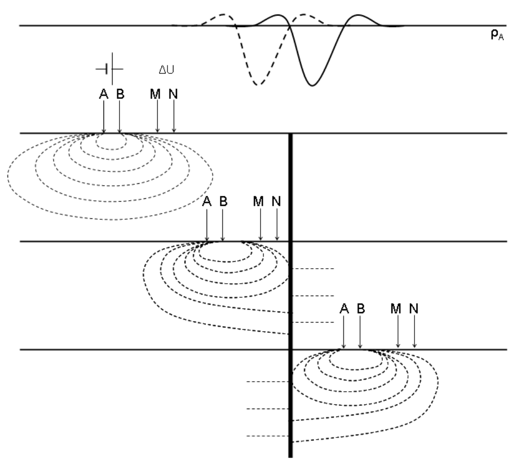

Fig. 5 Curves of the electric resistance over conducting structure

Fig. 5 is an example of how the applied geophysics can help in identification of the underground cavities. The array of electrodes is double dipole. A and B electrodes conduct the electric current into ground, while M and N electrodes register the difference of the electric potential. Dotted lines approximate the course of the electric current in the ground. The course of the apparent resistivity is depicted on the top line. The crossing of both curves indicates the conducting structure. It is necessary to emphasize, that applied geophysics indicates a phenomenon, not the presence of the desired structure directly. The complexity of the applied geophysics, as well as its capability or incapability is out of the size of this article. But the recommended literature can explain more [5].

4. Cavities Dug on Purpose

The history brings many examples of successful underground warfare, when undermined and subsequently blown-out fortifications resulted in a successful siege. Asymmetric warfare makes the clandestine infiltration from underground more presumable. A responsible commander of static military facility does not ignore this option and orders to apply measures to eliminate this threat.

4.1. Presumability of Risk

There are two options when the risk could be considered neglectable. The first of them is when the rocky subgrade composes a surface of the facility. Digging in those conditions is extremely difficult and cannot be done secretly. The second of them is the presence of the groundwater level just under surface. From this point of view, the water table just below surface is the best provision against any attempt for the underground incursion.

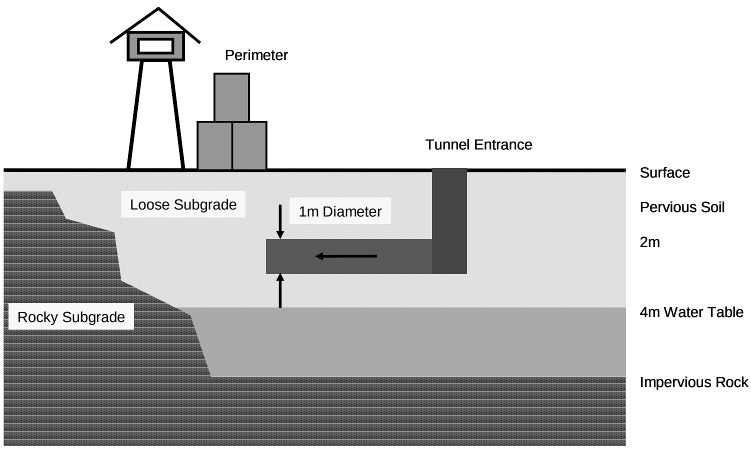

Fig. 6 Options to undermine the facility

The explanation of those options is in Fig. 6. The rocky subgrade, as indicated on the left, reaches the surface. If the excavation eliminates handy tools, so the surface facility could be considered safe against secret incursion from the underground. The second option, when a water table could protect the same facility, is depicted on the right. The loose material facilitates excavation. The author of this article has made a calculation that the thickness of the overlaying rocks shall be 2 meters a minimum to ensure stability of the hanging wall. Assuming a tunnel diameter of 1 meter, the water table should be 1 meter deeper. As a result, when the water table is about 4 meters under the surface and deeper, the underground incursion is feasible and the protective measures have to be applied [6].

4.2. Surface Symptoms of Underground Digging

The excavated subsurface tunnels may indicate their presence by the subsidence of the surface, as seen in Fig. 7 on the left. The hanging wall is bent along borderlines called "Angle of Break". This angle approaches 45° in argillaceous soil and 60° in arenaceous soil [7]. The subsidence basin has a shape like very shallow and long synclinal. The loose material composing hanging wall exerts its pressure on the tunnel reinforcement. In the case of exceeding the bearing capacity, the singular (discontinuous) subsidence occurs and we observe the same mechanism and symptom called sink hole, see subparagraph 2.2. That phenomenon is visible in Fig. 7 on the right.

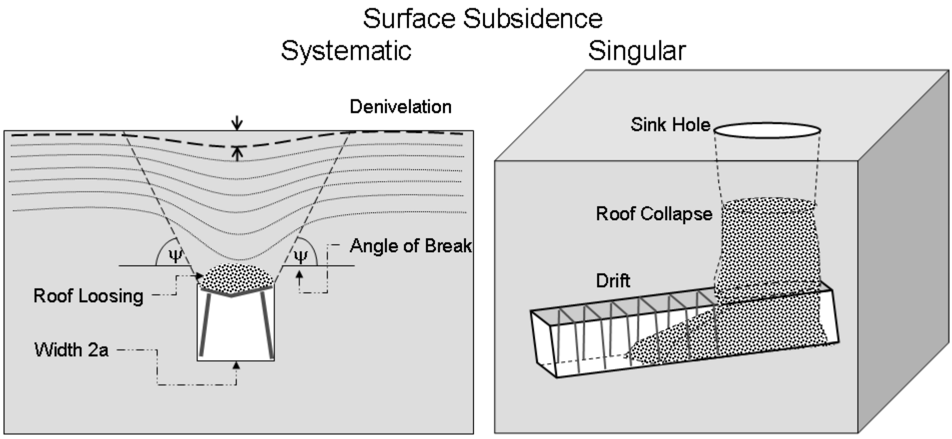

Fig. 7 Surface symptoms of underground digging

The denivelation of the surface is a regular phenomenon following each shallow underground digging. The technology, if any, is based on primitive tools like pick or shovel, while the reinforcement is done by improvised supporting material like timber, plywood, barrels, etc. The denivelation is visible on the surface. The width could not exceed 5 meters. The sink hole, as seen in Fig. 6 on the right, provides a definite decamouflage effect of the underground digging.

5. Conclusion

This article has explained where it is possible to expect underground cavities in view of the geological conditions. From the above-mentioned facts, the following conclusion is obvious: Mechanically originated cavities are frequent in conditions where the rock blocks are separated by narrow and deep fissures, joints or valleys. The typical material is sandstone or arenaceous marl, less granite.

Most underground cavities contain karst. Chemical leaching of limestone creates unpredictable amount of caves, partly corresponding to each other. The success in the defensive or offensive activities of karst region depends on the recognition of the underground space. To demolish entrances of caves could or could not lead to success. It depends on the number of openings of the particular karst subsystem.

The abandoned mining stopes are more dangerous for defenders due to their instability than to their assailant. The demolition of the entrance could be fatal for people inside. Karez, the water distribution system, has a predictable array of drifts and wells. People who are able to maintain it are able to adapt it for storage of material or illegal persons. Only repeatedly conducted inspections based on special tactics can prevent misusing of this water system. The risk of undermining of the perimeter could be reduced by proper vigilance of guards. They have to be instructed which symptoms indicate the attempt to conduct saps. The proper observation of the outskirts of the base can indicate excavated soil or tunnel entrance.

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