FOREIGN POLICY RESEARCH INSTITUTE

E-NOTES

"A nation must think before it acts." - Robert Strausz-Hupé

APRIL 2015

FIGHTING UNDER THE EARTH: THE HISTORY OF TUNNELING IN WARFARE

By Paul J. Springer

Paul J. Springer, Senior Fellow in the Foreign Policy Research Institute's Program on National Security, is an associate professor of comparative military history at the Air Command and Staff College, located at Maxwell Air Force Base, Alabama. He is the author of* America's Captives *(University Press of Kansas, 2010);* Military Robots and Drones *(ABC-Clio, 2013);* Transforming Civil War Prisons: Lincoln, Lieber, and the Laws of War *(Routledge, 2014); and* America's Wars: A Military History of the United States, 1500-Present *(Naval Institute Press, 2015). He is the series editor of* Transforming War *and* The History of Military Aviation*, both with the Naval Institute Press. His current research includes books on cyber warfare, military robotics, the West Point class of 1829, and higher education in the South from 1865-1900. He holds a PhD in history from Texas A&M, and has taught there and at the U.S. Military Academy at West Point.

Military strategists and pundits alike often refer to warfare in terms of three domains -- namely land, sea, and air. In each of these venues, armed combatants struggle to defeat their adversaries and open a path to the political objectives that drive a conflict. However, a fourth domain is often overlooked in discussions of warfare, one that has been utilized as a means of covert approach toward enemy forces for thousands of years, and has recently been utilized to great asymmetric effect against some of the most powerful conventional forces on earth. This forgotten domain is the use of underground tunneling, as a means to create a subterranean axis of advance. While it might not share the glamor of the other domains, it has often been used to decisive effect throughout the recorded history of human conflict.

Traditionally, tunnels have mostly been used as a means to approach and threaten fortified positions. An ancient besieging force might have begun tunneling operations in the hopes of bypassing a fortification's walls, and launching a direct attack upon the interior, achieving surprise by the sudden emergence of warriors in an area previously considered immune from attack. More common was the effort to open a space under protective walls or towers, a process called "sapping." The tunnel diggers shored up the foundations of the target area with dry wood planks until a prearranged time, at which the wood was ignited, causing a collapse of the newly-unsupported wall. The resulting breach was then stormed by infantry, who hoped to pour through the opening and overwhelm the defenders before the gap could be plugged.

Of course, ancient defenders knew the dangers of tunnel and sapping operations, and they devised means to detect any enemy tunneling activity. One method was to place drums at key points along the defensive line, and monitor them constantly for the telltale vibrations produced by digging through the earth. Others used bowls of water set along the tops of walls, which also responded to underground disturbances. These methods allowed a crude form of triangulation, by which the defenders could chart the progress of the approaching tunnels. Rather than passively await the enemy's maneuvers, they could then begin a countermine, attempting to intersect the attackers' tunnel. A brutal hand-to-hand fight in the darkness followed, with the desperate defenders hoping to kill the enemy miners and collapse their tunnels before they put the fortifications at risk. Sometimes, defenders attempted to flood attacking tunnels, or fill them with noxious smoke to render them uninhabitable.

Clear records of tunneling operations extend back more than 4,000 years. Assyrian carvings show engineering units belonging to Sargon of Akkad (reigned 2334-2279 BCE) undermining the walls of enemy cities. Although Homer's *Iliad* contains no mention of such activities, archaeological evidence from excavations at Troy show a number of underground passages crossing

beneath the city's walls, which might have been part of a siege. The Romans often used tunneling operations in their conquests, and their repute as engineers was so great that even the sight of freshly-dug earth that might indicate the presence of tunneling was enough to provoke surrenders. Defenders could not take the chance of a sack of their city if the Romans were forced to take it by storm. For their part, the Romans also proved adept at countermining operations. At the siege of Dura in C.E. 256, invading Persian tunnels threatened the walls and towers guarding the settlement. Roman defenders managed to intercept several Persian tunnels and collapse them, while also digging tunnels to attack a Persian siege ramp from below.

The influence of tunnel operations, and the threat of their success, can be seen in the evolution of fortification designs. Castles with high curtain walls required ditches around the walls as a means to force enemy diggers to tunnel through solid bedrock. This not only proved far harder to penetrate, but it also gave off a much louder sound for easier detection and counterattack. If the ditch could be flooded, the effect was even better, as water from the moat might seep into any tunneling operation and render it ineffective. No fortification could be truly immunized from tunneling operations, making the tactic a very attractive, although time-consuming, approach to siegecraft. Nations with extensive mining industries held a significant advantage in this type of warfare. In particular, English and German miners worked to elevate the creation of sapper tunnels into an art form, and often joined specialized mercenary engineering companies.

The introduction of gunpowder to European militaries had two significant effects upon tunnel warfare. First, it created a viable alternative means to quickly end a siege via the collapse of fortifications, as masonry walls could not withstand the power of direct artillery fire for very long. Of course, attackers still needed to bring their artillery within range of the walls, where defenders typically mounted large guns that could return fire. The process of working artillery into position to fire upon the walls soon called for a substantial amount of digging and maneuvering, which might be as slow and costly as the process of mining under the walls. The second major effect of gunpowder to this style of warfare was to increase the destructive power of sapper tunnels. Rather than burning the timber placed to prop up walls, a besieger could instead excavate a chamber under the wall and fill it full of powder. The explosion from this method could blow apart enormous sections of the enemy wall, although it often had the side effect of collapsing the tunnel at the same time.

Gunpowder spelled the end of the massive, imposing castle, but it did not convey a permanent advantage to the attacker. Soon, military engineers began to construct fortifications that utilized geometric calculations to allow defenders to cover every possible approach. Earthworks served to absorb the impact of enemy shot and shells, and could be built to prevent direct fire upon the primary defenses. The enormous fortification projects required the full resources of a nation-state, but also rendered wars of national conquest too costly to undertake. Limited wars, with the object of taking a single fortified position, might require multiple campaign seasons to be completed, unless besiegers could devise a way to bypass the new defenses. Tunneling again came to the forefront of the engineer's craft. Yet, the architects of massive fortifications did not neglect the possibility of a subterranean advance, in anticipation of such tactics, they included enormous networks of countermines well beyond their defensive perimeters. Such tunnels served as storerooms during peacetime, but were garrisoned with troops instructed to listen for the sounds of tunneling during times of war. Lest an enemy seek to break into the existing tunnel system and gain access to the fort, the tunnels were rigged with charges for easy collapse, traps for the unwary, and a labyrinthine design known only to the defenders.

At the turn of the nineteenth century, the Revolutionary armies of France, commanded and inspired by Napoleon Bonaparte, restored operational mobility to the battlefield as they swept across Europe. While Napoleon proved almost unstoppable on the battlefield, he had neither the patience nor the aptitude for conducting sieges. He much preferred to simply bypass fortified positions and threaten enemy capitals. For a short period, tunneling became a very uncommon aspect of warfare. By mid-century, though, it was prominent once more, with tunnels dug to attack Sebastopol in Crimea, and a major tunneling attempt to break the siege lines at Petersburg during the American Civil War. In both attempts, the institutional memory of how to create an effective sapper mine and exploit it failed, and neither proved very effective.

Tunnel warfare was never the exclusive province of western warfare, although the industrial economies of Europe made it a natural capability. Chinese military theorists dating back to Sun Tzu discussed tunnel warfare as a means of surprising and overwhelming an enemy who felt secure behind strong defenses. Other Asian military forces also practiced the art of military tunneling, particularly the Japanese, who besieged Russian-held Port Arthur in 1904. When attempts to storm the defenses failed, and artillery proved incapable of forcing the Russians to surrender, Japanese engineers began work on the largest military tunnel system to date. Hundreds of separate tunnels were driven toward the defenders, who recognized the danger and began searching for means to block or collapse them before they became a mortal threat. In December, several different mines were exploded, breaching the remaining defenses and triggering the surrender of the Russian defenders.

The use of mines inside tunnels as a mechanism to breach enemy trench lines continued as a means to end the stalemate of the Western Front of World War I. British, French, and German diggers all competed to drive tunnels past the enemy lines, either to create a breach or to infiltrate forces into the rear areas. The region around the Ypres salient, in particular, was festooned with hundreds of tunnels. Each side developed special equipment and techniques to enhance their chances of extending a mine, or of intercepting and destroying the enemy's attempts. When countermines broke into adversaries' tunnels, the result was a bloody melee deep below the surface. Given the need to seek out the enemy by sound, tunnel fighters used firearms and explosives only as a desperate last measure. Knives, bayonets, and mining tools were far more common weapons, although occasionally poison gas was used to render the tunnel unusable.

Tunnel warfare reached its logical extreme as a defensive system during the interwar period. In particular, the French military, devastated by the experience of the First World War, sought to design an impregnable fortification system, dubbed the Maginot Line, to prevent another massive German invasion. They constructed a chain of enormous forts along the German frontier and connected them by subway tunnels. Each position maintained interlocking fields of fire with its neighbors. All maintained a positive air pressure, preventing attack via poison gas. Virtually the entire position was rendered immune to aerial attack, and enemy field artillery stood no chance of reducing the positions. Tunnels under the network enabled an infantry counterattack at almost any point, and should an attacker manage to penetrate the tunnel system, it could quickly be collapsed via built-in demolition charges, meaning that even if one position fell, the line remained intact. To a certain extent, the plan worked—Germany did not even attempt an attack against the Maginot Line, and instead devised its entire operational plan to move through Belgium and bypass the forts. This guaranteed British intervention, but it also turned the Maginot Line into an enormous static position, completely incapable of preventing the conquest of France. For the remainder of the war in Europe, front lines remained fluid, preventing the need for sapper mines during the war against Germany.

In the Pacific, the Japanese strategy called for extending a defensive perimeter into the Pacific, building airfields to threaten any American naval counterattacks, and inflicting more casualties than the United States was willing to absorb while negotiating an armistice. One key mechanism of inflicting fatalities was through digging field fortifications on every island the Japanese occupied. Positions without airfields might be safely bypassed, but those with even a single runway presented too much danger to convoys and had to be attacked in a succession of bloody invasions. The longer Japanese defenders had to prepare before facing an amphibious assault, the more they dug into the earth. The tunnels offered protection from observation and aerial attack, and also enabled a significant number of tactical surprises as Japanese troops moved unseen below the islands. By the time the United States Marines attacked Iwo Jima in February of 1945, Japanese defenders had created a massive network of tunnels throughout the tiny volcanic island. The result was a bloodbath, with 6,821 Americans killed and a further 19,217 wounded. An operation scheduled to last three days stretched out to five, and became the bloodiest battle in USMC history. Had such a defensive scheme been followed during an invasion of the Japanese home islands, Allied casualties might have numbered in the millions.

One major U.S. military experience with the challenges of tunnel warfare came during the Vietnam War. Over decades of fighting first the French and later the U.S.-backed South Vietnamese government, Viet Cong guerrillas constructed an enormous tunnel network, particularly in the Cu Chi province near Saigon. This network offered shelter against overwhelming American airpower, and facilitated a hit-and-run style of warfare that continually frustrated American commanders. Desperate to come to grips with the enemy, the U.S. Army surrounded a region nicknamed the Iron Triangle in early 1967 and moved in with overwhelming force. The three week effort, dubbed Operations Cedar Falls, eventually netted 750 enemy killed and 600 weapons captured. Having seized the terrain, the U.S. military then sent in heavy equipment to raze the jungle cover and destroy the tunnels. After the demolition crews craped the earth bare and collapsed the tunnels, they abandoned the region, which was soon once again heavily overgrown and riddled with tunnels.

Certain troops, called "tunnel rats," specialized in penetrating and searching the Viet Cong tunnels. They disappeared for hours, relying upon their senses of smell and hearing for any warning that an enemy might be near. Armed with a long knife, a handgun, and a flashlight, they sought to nullify the massive advantage conveyed by the tunnels. Some men managed to conduct dozens of incursions, becoming comfortable crawling below ground, while others found they had unexpected phobias and could not continue their penetrations. When a tunnel rat announced he could no longer perform the mission, he was not questioned or cajoled to return below. He was simply welcomed back into the ranks of men who remained on the surface.

American troops attacking Al Qaeda positions and pursuing Osama bin Laden in 2002 discovered a massive tunnel complex connecting the natural Tora Bora cave formations in Afghanistan. These tunnels boasted hospital facilities, massive storerooms, sophisticated electronic communications gear, and a climate control system capable of filtering chemical contaminants. The effort to capture and destroy the tunnels was a tactical success but a strategic failure, as most of the Al

Qaeda fighters and all of the senior leaders escaped while a handful held off coalition attackers. Very little useful intelligence was captured when the coalition troops finally broke through, and much like the effort against the Cu Chi complex near Saigon, they contented themselves to collapse and seal off portions of the tunnels before abandoning the area. Unsurprisingly, enemy forces quickly reoccupied much of the region.

Tunnel warfare has recently come to the attention of western militaries due to its usage in the recurrent fighting between Israel and Hamas in Gaza. Hamas, founded in 1987, has always utilized tunnels as an efficient means of smuggling and infiltration, and Israel has largely tolerated the tunnels' existence because it seemed too costly to destroy them. After Hamas seized power as the formal government in Gaza, Israel enacted a blockade of items deemed contraband in Gaza, including construction materials likely to support tunnel construction. In particular, the importation of concrete was tightly controlled, a decision that provoked substantial derision in the international community. Regardless of such condemnation, Israel retained the restrictions as a key security measure. Tunnels also crossed the border into Egypt, where a 2011 revolution brought Mohamed Morsi to power. Morsi's administration proved very sympathetic to Hamas, but was overthrown by the military in 2013. General Abdel Fattah el-Sisi ordered military engineers to flood the tunnels with raw sewage, making them completely unusable without a shot being fired.

When a series of incidents triggered a renewed Israeli invasion of Gaza in 2014, one of the key objectives soon became the destruction or severe degradation of the tunnels under Gaza, particularly those crossing into Israel. The tunnels proved far larger, deeper, and longer than expected, and their stable construction made them all but impervious to airstrikes. Thus, any effort to collapse the tunnels required Israeli ground troops to enter them and place detonation charges inside. Naturally, Hamas resisted such advances using every means available, including traps, ambushes, and efforts to control the narrative of the fighting in the world press. Although the tactical moves inflicted some casualties upon the Israel Defence Force (IDF) troops, the propaganda campaign failed. Discoveries of missile caches used to attack Israeli civilians, as well as the capture of Hamas commandos armed with restraints and sedatives, who admitted to a plan to kidnap civilian hostages, massively undermined the campaign. After seven weeks, the two sides agreed to a cease-fire, although Israel continues both the blockade and the effort to collapse existing tunnels.

If irregular warfare remains common in the next few decades, as it has been for many recent conflicts, tunnels are likely to play an increasingly important role. Dominant conventional powers, most notably the United States, have a massive informational advantage provided by aerial surveillance. One way to offset some of the effects of this information dominance is to simply conceal activities, particularly underground. Tunnels can create a defensive nightmare for attackers, and negate many of the advantages held by a technologically superior conventional force. The process of clearing and destroying a tunnel network is expensive, time-consuming, and likely to inflict many more casualties than an engagement above ground. Tunnels also offer a dual-usage in peacetime, in that they provide infiltration and smuggling routes. If the entrances and layout of the tunnels can be kept secret, their existence creates a major security threat.

Many of the most effective countermeasures against tunnels have been used for centuries. If a specific perimeter needs to be defended against tunneling (such as the Gaza border), it is theoretically possible to create a deep ditch that would force tunnelers to dig through solid bedrock to reach their goals. Backed up by acoustic and seismic sensors, this passive defense can detect many of the tunneling efforts. Maintaining effective surveillance over areas suspected to have active tunnel-digging can also help, by checking for signs of soil being deposited in large quantities. Blockades and embargoes can limit the importation of heavy tunneling equipment. Ground penetrating radar has a limited ability to detect underground excavations. In the end, though, tunneling has been used for the simple reason that it works, and as such, it is unlikely to go away in the near future. It is not usually the first choice of methods, due to the time and resource requirements, but it tends to be a very effective, if slow, approach to military operations.

For further reading:

Barrie, Alexander. *War Underground.* London: F. Muller, 1962.

Barton, Peter; Peter Doyle; and John Vandewalle. *Beneath Flanders Fields: The Tunnellers' War, 1914-1918*. Staplehurst, Kent, United Kingdom: Spellmount, 2004.

Bradbury, Jim. *The Medieval Siege.* Rochester, NY: The Boydell Press, 1992.

Campbell, Duncan B. *Besieged: Siege Warfare in the Ancient World.* Oxford: Osprey, 2006.

Duffy, Christopher. *The Fortress in the Age of Vauban and Frederick the Great, 1660-1789*. London: Routledge, 1985.

Duffy, Christopher. *The Fortress in the Early Modern World, 1494-1660*. London: Routledge, 1979.

Ebert, James R. *A Life in a Year: The American Infantryman in Vietnam, 1965-1972*. Novato, CA: Presidio, 1993.

Gravett, Christopher. *Medieval Siege Warfare*. London: Osprey, 1990.

Hogg, Ian V. *The History of Fortification.* New York: St. Martin's, 1981.

Mangold, Tom and John Penycate. *The Tunnels of Cu Chi: The Untold Story of Vietnam.* New York: Random House, 1985.

Norris, John. *Medieval Siege Warfare*. Stroud: Tempus, 2007.

Rogers, Bernard William. *Cedar Falls-Junction City: A Turning Point.* Washington, DC: Department of the Army, 2004.

Stanton, Shelby L. *The Rise and Fall of an American Army: U.S. Ground Forces in Vietnam, 1965-1973*. Novato, CA: Presidio, 1985.