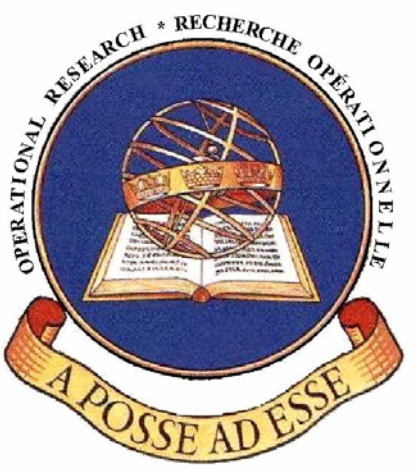
DEPARTMENT OF NATIONAL DEFENCE

CANADA



OPERATIONAL RESEARCH ADVISOR

DIRECTORATE LAND STRATEGIC CONCEPTS

RESEARCH NOTE 9906

HISTORICAL USES OF ANTIPERSONNEL LANDMINES: IMPACT ON LAND FORCE OPERATIONS

by

Roger L. Roy

Shaye K. Friesen

October 1999

KINGSTON, ONT, CANADA

National Défense
Defence nationale

OPERATIONAL RESEARCH DIVISION

CATEGORIES OF PUBLICATION

ORD Reports are the most authoritative and most carefully considered publications of the DGOR scientific community. They normally embody the results of major research activities or are significant works of lasting value or provide a comprehensive view on major defence research initiatives. ORD Reports are approved personally by DGOR, and are subject to peer review.

ORD Project Reports record the analysis and results of studies conducted for specific sponsors. This Category is the main vehicle to report completed research to the sponsors and may also describe a significant milestone in ongoing work. They are approved by DGOR and are subject to peer review. They are released initially to sponsors and may, with sponsor approval, be released to other agencies having an interest in the material.

Directorate Research Notes are issued by directorates. They are intended to outline, develop or document proposals, ideas, analysis or models which do not warrant more formal publication. They may record development work done in support of sponsored projects which could be applied elsewhere in the future. As such they help serve as the corporate scientific memory of the directorates.

ORD Journal Reprints provide readily available copies of articles published with DGOR approval, by OR researchers in learned journals, open technical publications, proceedings, etc.

ORD Contractor Reports document research done under contract of DGOR agencies by industrial concerns, universities, consultants, other government departments or agencies, etc. The scientific content is the responsibility of the originator but has been reviewed by the scientific authority for the contract and approved for release by DGOR.

DEPARTMENT OF NATIONAL DEFENCE

CANADA

OPERATIONAL RESEARCH ADVISOR

DIRECTORATE OF LAND STRATEGIC CONCEPTS

RESEARCH NOTE RN 9906

HISTORICAL USES OF ANTIPERSONNEL LANDMINES: IMPACT ON LAND FORCE OPERATIONS

By

Roger L. Roy

Shaye K. Friesen

Approved by: _____

Roger L Roy
Senior Op Research Advisor

KINGSTON, ONTARIO October 1999

ABSTRACT

In December 1997, the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Antipersonnel Mines and Their Destruction* was signed in Ottawa by 126 nations. Militaries are understandably reluctant to suddenly give up a weapon system that has been part of their doctrine and procedures for decades. One of the dilemmas is to determine if AP mines provide a significant effect on the modern battlefield and to quantify the capabilities that the antipersonnel mines provided. The aim of this study is to determine the impact of removing antipersonnel landmines on land force operations and to determine if replacement technologies are necessary. As the first report in a three part series, this research note examines the historical uses of AP mines in order to identify capabilities they provided.

RÉSUMÉ

En décembre 1997, 126 nations ont signé à Ottawa la *Convention sur la destruction et l'interdiction d'usage, de production et du transfert des mines antipersonnelles.* Les militaires sont réticents à renoncer soudainement une arme qui a fait parti de leur doctrine et de leurs procédures depuis plusieurs décennies. Le dilemme reste à déterminer si les mines antipersonnelles ont un effet significatif sur le champ de bataille moderne et de quantifier leur utilité. Le but de cette étude est de déterminer l'impact sur les opérations terrestres d'enlever les mines antipersonnelles et de déterminer si elles doivent être remplacées par de nouvelles technologies. Comme premier rapport dans une série de trois, cette note de recherche examine l'utilisation historique des mines antipersonnelles afin d'identifier leur capacités.

ACKNOWLEDGEMENT

The Canadian Centre for Mine Action Technologies (CCMAT) provided funding for this historical research. Special thanks to Maj. Harry Burke, DSTL-4, for guiding this work and providing opportunities to present the results to a wider audience.

EXECUTIVE SUMMARY

INTRODUCTION

The aim of this study is to determine the impact of removing antipersonnel landmines (AP mines) on land force operations and to determine if replacement technologies are necessary. As the first report in a three part series, this research note examines the historical uses of AP mines in order to identify capabilities they provided.

HISTORICAL FINDINGS

Although modern AP mines are explosive devices, their lineage and tactical usage can be traced to traps, concealed spikes and stakes that were employed by ancient armies. The development of electrical initiation systems in the second half of the nineteenth century greatly improved the reliability of early landmines by allowing more instantaneous firing. During the US Civil War, landmines instilled a degree of caution and prudence in the attacker, and caused psychological damage far more significant than injuries or deaths.

Despite the massive scale of the First World War, the use of AP mines was not widespread. Machine guns, artillery and barbed wire were used successfully to stop massed infantry advances. However, AP mines contributed to delays in advances, protected infantry positions; and delayed occupying forces after a retreat. The utilisation of AP mines saw a growing shift of focus in World War II from a singular device that was designed to cause fear or destruction to the individual, to a multifaceted antipersonnel weapon system that stressed area control. As modern production and explosive techniques improved, the use of AP mines became more practical and effective.

In the Korean War, the shrewd use of mines and obstacles proved effective when used to supplement more lethal means of defence, including trip flares, barbed wire, rifle, machine gun and mortar fire. Because AP mines were not capable of stopping massed infantry attacks, more refined devices such as the M14 “toe-popper”, the M18 Claymore directional fragmentation mine and the British No. 6 “carrot mine” were developed.

In the Vietnam War, the Viet Cong (VC) took AP mines out of their traditional defensive role and used them as offensive weapons to attack and harass their opponent. As a result, mines and booby traps caused up to 11% of US personnel killed in action and up to 15% wounded in action (compared to less than 4% in WWII and Korea), with most US casualties occurring during road clearing operations. In the Afghan and Falklands conflicts, mines never succeeded in prolonged obstruction to infiltration and infantry assault. In general, other barriers and weapons systems proved more effective.

In the Gulf War, the Iraqis developed formidable and complex minefields to blunt penetrations into Kuwait. These mines failed to slow, much less stop, the Coalition’s ground attack because the Iraqis were reluctant to aggressively patrol and defend their barriers, they placed too much emphasis on artillery, and they did not deploy effective anti-armour capability in forward areas. In addition, the Coalition had enough equipment to penetrate minefields and barriers without extensive dismounting, and had a decisive advantage in fire, air support and mechanisation during the operation.

In other insurgencies and limited wars, AP mines supplemented natural obstacles, prevented infiltration along borders, guarded strategic points along perimeter defences, and caused a large number of civilian casualties. Mines were increasingly used as population control devices by both sides in intra-state conflicts. AP mines have become a significant problem after conflicts because there was neither an effort to clear them nor any attempt to keep accurate records.

CONCLUSION

This study has provided some evidence regarding the operational effectiveness of AP mines. The lessons of history provide the following conclusions:

- The operational effectiveness of AP mines was dependent on a number of factors (i.e. the nature of the terrain, type of war, arrangements of weapons, training and tactics, and combat circumstances).
- The number of casualties produced was not always a crucial element in determining the impact of AP mines. The psychological and cascading effects of AP mines are difficult to record statistically.
- A systematic combination of other lethal weapons (e.g. tanks, air power, artillery, mortars, and machine guns) was equally, if not more, efficient and could be suitably used in place of AP mines.
- Although AP mines were not war winning weapons, they rendered movement at the lower levels difficult (especially when used in combination with AT mines) and influenced the pace of operations.
- AP mines used as obstacles proved relatively inconsequential if a sufficiently determined or concerted effort was made to overcome them.
- Even if AP mines were not always used effectively, the need to enhance combat effectiveness dictated that they be physically and technically adapted and then deployed to meet a wide range of situations.
- AP mines evolved as a unique weapon of war with specialized applications. Because of their flexibility, low cost, small logistical burden and ease of use, AP mines were perceived to be operationally effective and were depended on to provide many roles and functions.
- AP mines were used effectively in an *offensive* capacity by different cultures in diverse conflict settings. Western armies were often reluctant to use, readily accept or appreciate AP mines in this capacity.
- Difficulties in marking and recording friendly AP minefields and detecting and clearing enemy minefields frequently mitigated against the operational effectiveness of AP mines and made them hazardous to our own soldiers when they were engaged in combat.

As a result of the several functions provided by AP mines, further areas of investigation need to be pursued.

TABLE OF CONTENTS

HISTORICAL USES OF ANTIPERSONNEL LANDMINES: IMPACT ON LAND FORCE OPERATIONS

INTRODUCTION

1. The *Convention on the Prohibition of the Use, Stockpiling, Production, and Transfer of Antipersonnel Mines and On Their Destruction* was signed in December 1997 by more than 120 countries in Ottawa, Canada. The Mine Ban Treaty calls for the elimination of antipersonnel (AP) landmines, and provides a framework for the removal of mines from the ground, the destruction of stockpiles and manufacturing, as well as assistance to victims. The Mine Ban Treaty has been considered a remarkable achievement for global law and humanitarian considerations by most international observers. United Nations (UN) Secretary-General, Kofi Annan, has hailed the banning of AP mines as "a landmark step in the history of disarmament" and "a historic victory for the weak and vulnerable of our world"[1].

2. Canada has ratified the Anti-Personnel Mine Ban Treaty, thus imposing a number of new limitations on the types and use of antipersonnel weapons available to Canadian commanders. These limitations are affecting the mix of offensive and defensive options available to a commander to ensure operational success. These limitations include a total ban on the use of non-discriminating, victim-initiated antipersonnel weapons and on the non-discriminating emplacement of any other lethal antipersonnel weapons in areas where non-combatants are either the primary targets or at risk due to their number in the target area. There is an essential requirement to retain antipersonnel obstacles as part of our overall antipersonnel system to ensure the protection of our troops in combat and non-combat operations, and to optimize the effectiveness of our weapons during combat operations.

3. Militaries are understandably reluctant to suddenly forfeit a useful weapon that has been part of their doctrine and procedures for decades on humanitarian grounds alone. One of the dilemmas is to quantify the capabilities that the AP mine provided. In recent years, new weapon systems, surveillance devices and smart mines have been introduced into the inventory of most armies, providing new and sometimes overlapping capabilities. Therefore, before replacement technologies can be identified and developed, a decision must be made if the capability requires replacement or if other systems sufficiently fill the gap.[2]

AIM

4. The aim of this study is to determine the impact of removing the AP mine on land force operations, to determine if replacement technologies are necessary and, if so, what the requirements are.

---

[1] UN, Secretary-General, Kofi Annan, *Address to the Signing Ceremony of the Antipersonnel Mines Convention*, (Ottawa, Canada, 3 December 1997). The internet site is http://www.un.org/

[2] For discussion, see Canada, Directorate of Army Doctrine, "The Banning of the Antipersonnel Mine," *The Army Doctrine and Training Bulletin*, Vol. 2, no. 1, February 1999, pp. 6-8.

OBJECTIVES

5. The overall operational research study addresses the following objectives:

   a. identify the capability that the AP mine provided and identify those capabilities that should be replicated to compensate for their loss;

   b. examine the impact of removing the AP mine from land force operations at the tactical level;

   c. determine if a system to replace the capabilities lost by the removal of the AP mine is necessary; and

   d. if a replacement system is required, identify the requirements, alternative concepts and associated research efforts.

6. This Research Note is the first report of a three part series. This report addresses the first objective by examining the historical uses of AP mines in order to identify the capabilities that they provided. A second report will examine the impact of removing AP mines and determine if a replacement system is necessary by addressing whether the current weapons mix can fulfil the capabilities that need to be replicated. A third and final report will examine the Ottawa Convention and identify AP mine alternatives and associated research efforts.

BACKGROUND

7. Despite the recent attention of the media and humanitarian groups, the history of the AP mine has been consistently underreported and often misunderstood. Little dedicated research has been devoted to determine the value of AP mines based on historical experience. This does not mean that the effects or effectiveness of AP mines are not worth recording or analysing in detail. Given the ongoing nature of the debate, an examination of the historical evolution and development of landmine warfare is important to elucidate on the usefulness of these weapons. In order to more fully determine the impact of removing AP mines from operations, it is important to analyze the operational contributions that AP mines made by analysing the historical record of the AP mine's capability and effectiveness in intra-state conflicts, internal wars and low-intensity conflicts. It is thus very important to determine if AP mines provide a significant operational effect on the modern battlefield by looking at the apparent lessons of history and illuminating on the background of their use.

THE EARLY LANDMINES

8. Although modern AP mines are explosive traps, their lineage and tactical usage can be traced from non-explosive predecessors such as traps, concealed spikes and stakes that were employed by ancient armies. In the tactical defensive, the use of concealed spikes and stakes was almost identical to that of contemporary landmines. They were used by armies to enhance fortifications in static defence or to change the terrain to their advantage, often in the face of a stronger enemy.

9. The concept of landmines can be traced back 2,500 years, making it one of the oldest weapon systems in existence. Indeed, the concept of landmines has been employed from Roman times to the present day without modification. In 52 BC, in the campaign to

suppress a Gallic uprising against Roman domination, Julius Caesar created elaborate defensive fortifications around the town of Alesia to meet simultaneous threats. The purpose was to provide protection for the defenders while forcing the attackers to negotiate obstacles and concealed obstructions. On a number of occasions, the Gauls attempted simultaneous and determined efforts to assault the fortifications. Caesar's defences were able to pierce and impale the numerically superior Gauls, who failed to penetrate the defences. Although Caesar's use of goads, lilies and abatis was not decisive in and of itself, the Gallic attacks were blunted by the defences. Surprise attacks by the Gauls on Caesar's outer ring of defences proved a costly failure, with the pits and obstacles proving their worth.[3] The Roman lines held and the obstacles gave Caesar time to successfully deploy his limited forces to threatened areas.[4]

10. These actions provided an early indication of the usefulness of obstacles. They underscored the central tenet that the defence was a superior form of combat and showed how obstacles can been used as a "force multiplier" to boost defensive strength. The depth of the defences increased the time and resources required to clear a breach, and provided a buffer zone for defenders who remained out of range of attacking weapons. The obstacles forced the enemy into developing clearing methodologies, and safe lanes enabled defenders to launch attacks on a vulnerable flank.

11. The use of concealed traps and similar devices to pierce the feet of attacking soldiers or the hooves of horses, camels and elephants became a feature of war throughout the ages. Armies employed four-spiked caltrops as early as the fifth century BC, and the technology was assimilated for regular use in defence.[5] From the Renaissance onwards, the use of caltrops was widespread among European countries and used by early settlers in the US against Indians. The introduction of gunpowder for military purposes led to the introduction, proliferation and gradual improvement of landmines. The earliest gunpowder landmines were termed fougasses—essentially an underground cannon that was placed in defensive positions to fire rocks and debris.[6] The fougasse had only a minor effect on land operations because it was rarely decisive, was vulnerable to the elements and was frequently unreliable. However, under certain circumstances it caused casualties, as in the Peninsular Campaign during the Napoleonic Wars.[7] Though the fougasse had the potential to stop a massed attack, it was peripheral to the main weapons systems and the efforts of the defenders.

12. The Chinese employed the first self-contained explosive AP mines against Mongol invaders during the 13th century. Manufactured in many different shapes and sizes, these mines could be command detonated or activated with either a pressure or pull-firing device. Early European target-activated mines consisted of buried black powder activated when stepped on, or by a trip wire along the ground that released a flintlock igniter to fire the main charge. Like the fougasse, these devices were highly vulnerable to dampness and required frequent maintenance, which limited their use mainly to reinforce the defences of fixed fortifications.[8]

---

[3] Lawrence Keppie, *The Making of the Roman Army: From Republic to Empire*,(Norman, University of Oklahoma Press, 1998), pp. 89-94

[4] Major William C. Schneck, "The Origins of Military Mines: Part I", *Engineer*, Vol. 58, (July 1998), p. 50.

[5] Caltrops were used as recently as the Korean War, when the US Air Force dropped them on Chinese convoys to puncture tires. The US also dropped them on the Ho Chi Minh trail during the war in Vietnam. William C. Schneck, 1998, p. 50.

[6] Mike Croll, *A History of Landmines*, (Barnsley, Leo Cooper, 1998), pp. 8-9.

[7] William C. Schneck, 1998, p. 52.

[8] William C. Schneck, 1998, p. 52.

THE US CIVIL WAR

13. The development of electrical initiation systems along with improved manufacturing techniques in the second half of the nineteenth century greatly improved the reliability of landmines. The introduction of explosive shells in the West by the late 1700s, combined with the invention of the percussion cap, made AP mines more reliable by improving their resistance to moisture.[9] This produced more enduring results during the American Civil War (1861-1865), which also saw the introduction of mass-produced weapons. As a result of the early success of sea mines employed against Union war ships, the Confederates introduced landmines to land warfare.

14. Confederate forces used landmines in an attempt to redress the imbalance between the competing armies. Pressure-operated mines were deployed in belts to create or enhance defensive positions, or individually to inflict casualties and create caution. By using explosives, early landmines were capable of producing casualties, ranging from amputation of limbs to death. The psychological effect of pressure-operated mines was considerably greater than the caltrop. The Confederates used pressure mines to enhance their defensive positions and to ensure the Union troops were exposed to as much attrition as possible. Landmines produced caution in the mind of attackers.[10] In addition, victim operated mines could impose a delay during a withdrawal without sacrificing troops in rearguard actions. Although lacking the range and destructiveness of the fougasse, the pressure-operated landmine had several advantages: it was easier to conceal, less susceptible to artillery disruption and did not require a firing party.

15. The invention and use of mines has been attributed to Captain Gabriel J. Rains of the Confederate States Army. During the Seminole Wars in Florida in 1840, with his troops outnumbered and continually being ambushed by the Indians, Rains had experimented with booby traps (improvised explosive devices). In 1862, commanding a garrison of 2,500 men at Yorktown and faced by General George B. McClellan's Union Army of 100,000, Rains prepared minefields in front of fortifications by burying mines made from artillery shells that would explode when stepped on. On 4 May 1862, pressure-operated landmines claimed their first victims. During the retreat to Richmond, Rains ordered Confederate soldiers pursued by Union troops to bury mines in their retreating path to "mainly have a moral effect in checking the advance of the enemy…[and]…to save our sick"[11]. In a number of instances, dummy mines were used to frighten Union troops. After Federal cavalry suffered casualties from the mines, they refused to move further until the roadway was swept, which left Rains time to escape safely to Richmond.

16. The Confederates later maintained the Union Army overestimated the number of mines and the extent to which they were used during the Peninsula campaign. The Rebels themselves never knew how many were actually laid, since mines were used haphazardly and no records were kept. The salient points are not these debates, but what was accomplished. The Union advance was slowed - as McClellan admitted. The retreating Confederates reached their objectives and bought enough time to fight a delaying battle. Although Union casualties may have been insignificant, the troops learned to respect and fear a new weapon, whose psychological effects became more important than physical

---

[9] William C. Schneck, 1998, p. 52.
[10] Mike Croll, p. 15.
[11] Milton F. Perry, *Infernal Machines: The Story of Confederate Submarine and Mine Warfare*, (Louisiana State University Press, 1965), p. 24.

damage. As the Union army approached Richmond, men felt they saw mines everywhere. Letters and diaries reveal a fear of an unknown weapon. One soldier reported: "You could not tip over a barrel or anything else, but what had a string attached to a big shell or…torpedo, that would kill five or six men every time they did anything or moved anything. Wherever you could see dirt thrown up loosely, look out for your feet, or…shells would explode". Another Union soldier commented: "A blood stain on the ground where a man was blown up…and a little red flag ten feet from it, admonished us to be careful. The rebels have shown great ingenuity...for our especial benefit"[12].

17. The employment of landmines underwent serious discussion on both sides. On 11 May 1862, Confederate General Longstreet, Rains' commander, forbade laying additional mines because he did not recognize them as "a proper or effective method of war"[13]. Confederate enlisted men felt that "this is barbarism!"[14]. Secretary of War George W. Randolph vindicated Rains by stating that it depended on the way in which mines were used. Civilized warfare did not allow killing for its own sake, only to achieve a definite military advantage. Mines could be placed on roads to delay pursuit and in front of defensive lines to repel attack. An outraged McClellan vented his ire at mine warfare in a telegram to his superiors:

> The rebels have been guilty of the most murderous and barbarous conduct in placing torpedoes within the abandoned works near wells and springs; near flag staffs, magazines, telegraph offices, in carpet-bags, barrels of flour etc…I shall make prisoners remove them at their own peril…it is the most murderous and barbarous thing I ever heard of.[15]

18. The situation was probably far less serious than these statements indicate because the first reports were made under stress and embellished the historical record. Although only a few of the buried shells were actually exploded, injuring or killing perhaps three dozen men, the psychological damage was more significant, and caused an atmosphere of fear to pervade the operations of the oncoming Union forces.[16]

19. Union troops used artillery bombardments to disrupt minefields, but these procedures added to the logistic burden by forcing armies to manufacture, transport and fire more ammunition, and make the ground more difficult to assault. The early mines increased the time required for the campaign and added to the resource burden of the attacker.

20. The use of landmines continued as the war progressed. Federal troops tried to use landmines, but were not as proficient as the Confederates. As General William T. Sherman advanced in the West, he encountered many landmines. At Fort McAllister, near Savannah, GA in December 1864, the Union army ran into large concentrations of landmines. When Sherman's forces attacked, mines exploded as soldiers stepped on them, killing twelve and wounding about eighty. At first, Sherman was outraged, but he became resigned to a point, stating that:

> I now decide the torpedo is justifiable in war in advance of an enemy. But

---

[12] Milton F. Perry, p. 21.
[13] Milton F. Perry, p. 25.
[14] Milton F. Perry, p. 25.
[15] Milton F. Perry, p. 22.
[16] Milton F. Perry, p. 23.

> after the adversary has gained the country by fair warlike means…the case entirely changes. The use of torpedoes in blowing up our cars and the road after they are in our possession is simply malicious. It cannot alter the great problem, but simply makes trouble.[17]

21. During the siege of Spanish Fort, advancing Union forces came upon landmines. They were a problem more because of their effect on the men's morale than their actual power of destruction:

> They were placed upon all approaches to the rebel works, and in every path over which our troops would be likely to pass. Even the approaches to the pools of water, upon which the men relied for cooking, were infected with them. As their explosion depends entirely upon their being stepped on, very few of them were effective, and the cases, in which men, horses, or wagons were injured were isolated. Still, the knowledge that these shells were scattered in every direction would necessarily produce its effect upon the troops, who never knew when to expect an explosion, or where to go to avoid one.[18]

22. Confederate entrenchments at Petersburg during the later operations of the war allowed an allocation of only two companies per mile to hold the works to the rear of belts of landmines. The economy that landmines provided the defender instilled caution and prudence in the attacker, as one passage noted: "Elsewhere dummy mines were frequently established…the fact that such mines were never passed over by an assaulting column proved that they did their work"[19].

23. The total number of landmines used during the Civil War was probably less than 20,000, returning in total perhaps a few hundred casualties. The numbers however conceal the importance of the weapons, which imposed delays, induced caution and reduced morale. However, landmines played a minor role in military actions of the Civil War because, except in static defence, they lacked the necessary flexibility. Unlike other weapons, they took time to prepare and once deployed, they could not be moved to engage a manoeuvring enemy, though their deterrent effect may have been sufficient to justify the effort in constructing them.[20]

MINE USE PRIOR TO 1914

24. During colonial expeditions, the British Army used landmines in the Sudan campaign (1884-1888) and the Boer War (1899-1902) to help secure lines of communication from sabotage by hostile natives and Boer commandos. In Sudan, during the defence of Khartoum, British officers believed that landmines were an effective form of defence: "In warfare against the savage nations, mechanical mines were very useful in fighting the natives"[21]. In South Africa, mines were laid to protect defensive positions, communications, and logistical lines.[22] After laying mines to protect a railway, a Royal Engineer noted the moral effect: "although the line had been injured for eight successive

---

[17] Milton F. Perry, p. 165.
[18] Milton F. Perry, pp. 186-187.
[19] Mike Croll, p. 12.
[20] Mike Croll, p. 12.
[21] Mike Croll, p. 20.
[22] *History of the War in South Africa, 1899-1902*, compiled by the direction of His Majesty's Government, (London, Hurst and Blackett Limited, 1908), p. 145.

nights before the mines were laid, it was never interfered with…after the first explosion"[23].

25. With the dawn of the twentieth century, the concept of landmine warfare was gradually institutionalised and had permeated most regular armies. Landmines were employed during the Russo-Japanese War (1902-1904) to defend trenches. These included electrically initiated, vibration and pressure sensitive mines. Narratives from officers who took part in attacks when mines were exploded stated: "Beyond covering everyone with mud, no harm was done, but the suddenness of the occurrence at a moment when the nerves of everyone were in a state of high tension alarmed the men, who ran back from the hillside to the road and entanglement in the rear in order to seek cover"[24]. Although mines were vigorously employed at Port Arthur, the Japanese made breaches in the Russian defences. Many of the landmines laid did not explode. Even when the mines functioned, positions were occupied with little difficulty. However, the Russian defences were generally acknowledged as weak.[25]

26. Though landmines of various types have been used in warfare almost since the appearance of gunpowder, before the First World War they were improvisations and used comparatively ineffectively. According to a prominent historian of technology, Martin Van Crevald:

> The evolution of weapons of war is not solely governed by rational considerations pertaining to their technical utility, capabilities and effectiveness. Technology is also intertwined with anthropological, psychological and cultural factors. These factors frequently push the development of weapons down seemingly illogical and irrational paths in which weapons such as the AP mines are considered unfair, since they enable their users to kill from a distance and behind cover, with the victim being chosen indiscriminately and unable to retaliate.[26]

27. Since early AP mines succeeded in fulfilling a purpose, they demonstrated a certain value in warfare. Mines were unorthodox and possibly even uncivilized, but they worked. They did not necessarily determine the outcome of battles, but they helped to delay troop movements and spread debilitating fear.[27] The use of landmines was moderated only by tactical demands and, as the technology of the period evolved, landmines moved from rudimentary containers to electrically initiated, victim-operated traps designed and placed to alter the nature of the ground or to enhance defensive fortifications. Although positions could have been successfully defended without the use of AP mines, another capability was added to the defenders' arsenal.

THE FIRST WORLD WAR

28. Between the US Civil War and the First World War, powerful military explosives were introduced that significantly increased the lethality of mines. Shells of the Civil War burst into a few low-velocity fragments. By World War I, high explosive shells produced about 1,000 high-velocity fragments.[28]

---

[23] Mike Croll, p. 21.
[24] General Staff, *The Russo-Japanese War*, Reports from British Officers attached to the Japanese and Russian Forces in the Field, Vol. I (London, Eyre and Spottiswoode, 1908), p. 258.
[25] General Staff, *The Russo-Japanese War*, Vol. II, pp. 368-369, 408, 409.
[26] See Martin Van Crevald, *Technology and War: From 2000 B.C. to the Present*, (New York, The Free Press, 1989), Chapter 5.
[27] Philip C. Winslow, *Sowing the Dragon's Teeth: Land Mines and the Global Legacy of War*, (Boston, Beacon Press, 1997), p. 129.
[28] William C. Schneck, 1998, p. 52.

29. Despite the massive scale of the First World War (1914-1918), the use of AP mines was not widespread because new weapons of the industrial age gave rise to defensive tactics and technology that marginalized them.[29] In a static war of siege, AP mines were not required to stop a massed infantry attack. Barbed wire littered across no-man's-land, machine guns and rapid-fire artillery accomplished the task, resulting in far more devastation than the use of mines. Throughout the war, AP mines, mostly made from adapted artillery shells, were laid in abandoned positions in anticipation of an enemy advance; a tactic designed to prevent the rapid occupation of defensive locations. Simple pressure fuses and delay action charges were manufactured specifically to cause casualties. Tripwire-activated mines were placed within the wire entanglements, where they were liable to be as dangerous to friendly troops as to the enemy.[30]

30. The Germans systematically used mines to add to Allied labours. Long-delay AP mines were buried by the Germans in abandoned positions and roads to harass advancing Allied forces. As the official history notes, "Owing to these conditions, progress was much slower than the circumstances demanded, and the opportunity to turn an unprepared retreat into a rout could not be taken advantage of"[31]. The Allies were equally proficient in their use of AP mines. When German soldiers in one brigade began their methodical attack in March 1918, their leading assault lines entered minefields and exploded buried charges with sensitive fuses: "A panic ensued and the advance was brought to a standstill for a considerable time"[32]. The use of AP mines also caused friendly casualties. For example, at Givenchy, British mines did more damage to the attacking Canadians than German defenders.[33]

31. The success of the AP mine in the First World War was not great enough to encourage a reliance on it. Although tactics and technology confined the use of AP mines on the Western Front to a minor delaying role, they were used as shock weapons to provide defensive barriers and to close roads. In East Africa, improvised shells, a design based on a rifle trigger mechanism and types of pipe mines that were made by packing dynamite into a water pipe, were some of the first operational devices calculated to wound by the blast effect of the projectiles, rather than to kill.[34] During the Dardanelles campaign, nearly the whole northern shore had been sown with landmines. The exploding contact mines caused many deaths to the landing troops and led to delay and confusion.[35]

32. Central to the occurrence of fear in battle was the soldier's ability to do something about a weapon system. Whereas aimed rifle fire was a direct, personal threat controlled by another individual, AP mines were not. In this respect, AP mines occupied an important place in the First World War because they were fear-producing agents used to demoralise the adversary. This stems in part because they were not only impersonal and inhumane, but they could strike anytime, without warning, and helped to extend fear and terror through the ranks.[36]

---

[29] See Hubert C. Johnson, *Breakthrough! Tactics, Technology, and the Search for Victory on the Western Front in World War I*, (Novato, Presidio Press, 1994).
[30] Mike Croll, p. 26.
[31] Brigadier-General Sir James E. Edmonds and LCol R. Maxwell-Hyslop, *History of the Great War, Military Operations in France and Belgium, 1918*, Vol. V, (Nashville, Battery Press, 1947), p. 492.
[32] Brigadier-General Sir James E. Edmonds, *History of the Great War, Military Operations in France and Belgium, 1918*, Vol. I, p. 298.
[33] Desmond Morton, *When Your Number's Up: The Canadian Soldier in the First World War*, (Toronto, Random House, 1993), p. 150.
[34] Mike Croll, p. 28.
[35] Henry W. Nevinson, *The Dardanelles Campaign*, (London, Nisbet and Company, 1918), pp. 301, 304, 308.
[36] Richard Holmes, *Firing Line*, (London, Johnathan Cape, 1985), p. 211.

33. Along with the advent of the tank and continued improvement of armour, the Anti-tank (AT) mine became one of the key components of the defence against tanks. AP mines were laid to protect AT mines from enemy breaching parties, but a minefield covered by machine gun fire was sufficient to deter clearance. As described earlier, AP mines had been used before the introduction of the tank to protect infantry positions from enemy soldiers or to delay occupying forces after a retreat.[37]

THE INTER-WAR YEARS

34. The development of military technology in general and of landmines in particular was a desultory affair immediately after the First World War, with most countries resigned to avoid another war. Given the new dimensions of mobility through the use of tanks and aircraft, many questions were raised about the nature of future conflict. The strong economic and emotional scars left in the wake of the war were not strong foundations upon which to rebuild military arsenals incorporating new technology. Most countries had remembered the devastating effects of the First World War, but had learned very little from it. Little had been achieved in practical terms before the outbreak of hostilities in 1939.[38]

35. When tensions in Europe mounted in the 1930s, the role of landmines was resurrected. It was recognised that mobile warfare seldom allowed time for the construction of tank obstacles other than AT minefields.[39] It was felt that the chief objectives of land mines were to delay an enemy advance, impair morale, destroy personnel and interrupt operations after ground had fallen into enemy hands. Yet, the utility of landmines depended on the purposes for which they were laid. High explosive shells and mortars could be used in place of mines. Field manuals explored the concept of dummy mines to "increase the apparent size of a minefield and for purposes of deception in areas that are not mined"[40]. AP mines and improvised charges or traps were not as a rule very destructive to personnel, "but the atmosphere of uncertainty they produce has a considerable moral effect on advancing troops and may deter them from [occupying abandoned positions]"[41]. Various types of mines, methods of laying and firing arrangements were examined.[42]

36. A majority of the inter-war doctrine manuals and training exercises involved AT mines and countries were recognising the importance of land mines and postulated that they would be laid in large numbers in future wars. AP mines of various forms had been used by militaries for decades, but they did not feature in pre-Second World War training scenarios, since it was almost impossible to obtain them.[43]

37. Landmines became recognised as an artifice of regular warfare and a contrivance of irregular warfare as well. For example, tribesmen in India used landmines against the British in the winter of 1930-31. Such experiences opened up fresh fields for serious military consideration in future operations. A British Brigadier had noted that "the natural features of such country provide numerous opportunities for an extended use of land mines

---

[37] Stockholm International Peace Research Institute (SIPRI), *Antipersonnel Weapons*, (New York, Crane, Russak and Company, 1978), p. 181.
[38] Mike Croll, p. 33.
[39] War Office, *Manual of Field Engineering*, Vol. I, (London, 1933), p. 44.
[40] War Office, *Manual of Field Engineering, Royal Engineers, V*ol. II, (London, 1936), p. 295.
[41] War Office, *Manual*, Vol. II, p. 296.
[42] War Office, *Military Engineering, Defences*, Vol. II, (London, 1937), p. 86.
[43] See Major R.M.H. Lewis, "Anti-Tank Classification and Field Firing", *The Royal Engineers Journal*, Vol. LIII, (Chatham, 1939), pp. 403-418.

to add considerably to the difficulties and obstacles already to be surmounted in Frontier operations"[44]. Besides being unpleasant, the use of landmines "caused, some anxiety, since it was extremely difficult - if not impossible - to search and to guard continually and thoroughly the very large area in any part of which mines could have been laid to hamper the movements of troops and transport as well as of armoured cars"[45].

38. The mere presence of landmines in this situation caused a definite danger to the daily maintenance of convoys, which had to be delayed until roads were swept. Though the methods of employment of landmines was somewhat primitive, and the successes they achieved insignificant, the endeavour was given credit, particularly in regard to future possibilities: "it will not be difficult to visualise numerous occasions and situations when land mines would form a serious problem to the progress of operations"[46]. These comments clearly foreshadowed coming events. With the increasing tensions and threat of another major war in Europe, countries had once again begun to consider the potential of mines.

THE SECOND WORLD WAR

39. The use of AP mines during the Second World War saw a growing shift of focus from a singular device that was designed to cause fear or destruction to the individual, to a multifaceted antipersonnel weapon system that stressed a full-fledged concept of area control. This trend was exemplified by the changes in mine warfare that had occurred during the inter-war period. Technical improvements enhanced the effects of AP mines, including blast and fragmentation. Detonation was by contact, pressure switch or by trip wire. This not only increased the lethal effects of AP mines, but it had also made the weapon itself highly adaptable and compatible to the environment in which it was employed. Trip wires were used to increase the chance of detonating a mine and to ensure wider area coverage.

40. All armies engaged in the massive use of AP mines during the Second World War, but none mastered the craft like the Germans. By 1939, the Germans had developed the most modern landmines and mine-warfare techniques. The German influence on mine warfare was significant because of the scale, meticulous procedural formality and technology they used. Mines were incorporated into the overall tactical setting, and were constantly updated to defeat countermeasures. Mines were laid in distinct, mathematically defined patterns to ensure a higher kill ratio. They were laid according to several principles: they should be marked and recorded, covered with small arms fire, used to enhance other obstacles (ditches and wire), and mixed fields of AT and AP mines should be laid. Tactical (in front of defensive positions), nuisance (along lines of communication), random (a positions likely to be occupied by enemy), and dummy minefields were employed.

41. AP minefields were almost always covered with fire, normally from both small arms and anti-tank weapons. Often, the Germans would wait until the enemy had infiltrated well inside the minefield before opening fire. This tactic was effective because the enemy had little opportunity to extract themselves, as an American soldier recounted:

---

[44] Brigadier-General E.B. Mathew-Lannowe, "Land Mining in Frontier Warfare", *Journal of the Royal United Service Institution, RUSI,* Vol. LXXIX, (February to November, 1934), p. 339.
[45] E.B. Mathew-Lannowe, p. 342.
[46] E.B. Mathew-Lannowe, p. 344.

> At the first sound of exploding mines, the Germans would lay down protective fire…some men elected to remain erect through intensive fire rather than risk falling on a mine. Nothing was feared more than mines; they were insidious, treacherous things, hiding in deep grass and in the earth.[47]

Such experiences on the effects of German AP mines on soldiers led General George Patton to make the observation: "The effects of mines is largely mental."[48].

42. The Germans were able to engineer and produce mines following a number of fundamental principles: they were reliable, economical, simple, durable and used standardised sizes and interchangeable parts to ensure compatibility.[49] Although modern self-contained fragmenting AP mines had been employed in relatively small numbers since the US Civil War, new types of fragmenting AP mines emerged during the Second World War, such as bounding mines (predecessors to the M16 "Bouncing Betty"), directional mines (predecessors to the M18 Claymore), and simple fragmenting mines (such as the later Soviet POMZ-2).[50]

43. From 1942, as the Germans fought almost entirely on the defensive, they placed an increasing importance on mines as a weapon of attrition, to disrupt, delay and inflict casualties on Allied forces, producing what American General McNair claimed was "almost a new arm of warfare"[51]. AP mines were increasingly introduced to protect the vast fields of AT mines being sown. AT mines were used to deflect and hold enemy mechanised forces in killing zones, while the AP mine exploited the vulnerability of dismounted infantry when they were separated from vehicles and armour. Mines forced attackers to negotiate obstacles in an unplanned manner.

44. As clearance techniques improved, the AP mine developed in phase including measures to complicate hand lifting and to thwart electronic detection. New devices, such as the Schrapnellmine (or S-Mine) which was activated by pressure on prongs or by a trip wire to produce shrapnel, marked a significant technical improvement on the early fragmentation devices. Wooden-cased pressure AP mines such as the Schützenmine (or Schümine) were designed to thwart electronic mine detection. The Germans also manufactured non-metallic mines from glass, plastic and Bakelite to overcome the problems of detectability and durability, although they were never produced in great numbers. Towards the end of the war, the Germans experimented with magnetic-influence, vibration-sensitive and radio frequency induced fuzes.[52]

45. It was realised that AP mines had a much wider application than defending AT minefields. Despite the increase of mechanisation during the war, a majority of the troops operated on foot and became targets for AP mines. With exceptions, AP mines were not designed to kill but were intended to wound and render soldiers immobile. This ensured that they were unable to continue their task and required others for evacuation and

---

[47] Mike Croll, p. 41.
[48] George Patton, *War as I Knew It,* (Boston, Houghton Mifflin, 1975), p. 406. A modern study has sought to determine the effect of AP mines on soldiers when they are used in military operations. See Eugenia M. Kolasinski, *The Psychological Effects of Antipersonnel Landmines: A Standard to which Alternatives can be Compared,* (West Point, Department of Behavioral Sciences and Leadership, Engineering Psychology Laboratory Report 99-2, 1999).
[49] Mike Croll, p. 42.
[50] William C. Schneck, 1998, p. 53.
[51] Mike Croll, p. 37.
[52] Mike Croll, pp. 43, 48.

medical treatment, imposing a greater logistical burden.[53] When the victim triggered a mine, by tripping the mine wire or stepping on the mine, the relationship of mass to velocity of the many fragment types made AP mines effective and deadly weapons. As a result, the victim suffered multiple severe wounds.[54]

46. During the war, many attempts were made to obtain a true picture of minefield casualties upon which the provision of body armour and mine-gapping drills might be based. Apart from some wounds, exact information was difficult to obtain under operational hindrances and fire. Moreover, some statistics were extended to include other weapons. It was usually impossible to determine the exact nature of the casualties from mines, except when the operator's foot set off the mine. Mine clearance programs after the war presented opportunities for the study of casualties during mine-clearing operations, but the results were not always representative of battle conditions.[55] Although these studies demonstrated the limited value of personal protective armour, they confirmed the high fatality rates for the S-mine and the value of drill for reducing casualties in a minefield. The area of effect of the S-mine (2800-2900 sq. ft) was comparable to theoretical estimates made during the war.

47. The AP mine took on a fiendish character in the minds of troops. It was a very personal enemy that crippled, mutilated and maimed on a seemingly individual basis.[56] The German S-mine was "probably the most feared and respected device encountered by Allied troops in World War II"[57]. Thousands of S-mines were laid along the Siegfried Line in October 1944. One American officer of a reconnaissance platoon, Lt. George Wilson, had a hair-raising experience and wrote: "By now, I had gone through aerial bombing, artillery and mortar shelling, open combat, direct fire and machine gun firing, night patrolling and ambush. Against all of this, we had some kind of chance; against mines we had none. The only defence was not to move at all"[58]. Soldiers that ran up against the S-mine took every precaution. Many became casualties when they were caught up in AP minefields. After the war, Wilson declared that the S-mine was "the most frightening weapon of the war, the one that made us sick with fear"[59]. The German S-mine proved so formidable, that operational research groups were tasked to investigate ways of minimising its lethality.[60] In consequence, bunching was found to be dangerous and conversely the reduction in casualties could be obtained by dispersion.[61]

48. Although these considerations may seem cold, cynical, and a pitiless form of combat, the wounding mechanism and fragmentation effects of AP mines were immensely practical for warfighting. AP mines were cheap and an army did not require much material to cover vast areas. For defending armies, they required less transport and were easy to bury and conceal. For the attackers, they were difficult to locate and made care of the wounded a burden on medical and transport resources. Early mines were made of metallic

---

[53] C.E.E. Sloan, *Mine Warfare on Land,* (London, Brassey's Defence Publishers, 1986), p. 36.
[54] Eric Prokosch, *The Technology of Killing: A Military and Political History of Antipersonnel Weapons,* (London, Zed Books, 1995), pp. 22-26.
[55] DHH 91/165, "Minefield Casualties", September, 1945.
[56] For wounds, see Canada, Chief Intelligence and Security (CIS), *A System of Pathogenic Treatment of Gas Wound Infections: Injuries Caused by Mines and Fire Weapons,* (Ottawa, Department of National Defence, 1987).
[57] C.E.E. Sloan, p. 36.
[58] Stephen A. Ambrose, *Citizen Soldiers: The US Army from the Normandy Beaches to the Bulge, to the Surrender of Germany, June 7, 1944-May 7, 1945,* (New York, Simon and Schuster, 1997), p. 143.
[59] Stephen E. Ambrose, 1997, p. 144.
[60] DHH 171.009 (D156), "The Lethality of the German 'S' Mine" , 29 April 1943/31 August 1944. Casualties could be reduced by about 30% if troops took advantage of the delay between ignition and detonation by running away from the mine or by lying down.
[61] DHH 322.009 (D459), "The German S-Mine 35", Apr 44/Aug45.

containers, but with the development of mine detectors, many were made of glass, earthenware or plastic to prevent detection. In addition to being difficult to locate (especially the non-metallic varieties), AP mines were psychologically demoralising and inhibited aggressiveness. The use of AP mines carried malicious intent, but this was practical and efficient in military terms.[62] With the addition of trip wires, fewer AP mines were needed to cover an area, freeing resources for other tasks. AP mines were a by-product of the growing industrialisation and mechanisation of warfare. Just as armies of previous times used weapons to enhance terrain and economise on the defensive, the modern exploitation of AP mine technology was dictated by a similar need to improve military efficiency and maximise the probability of fatalities.

49. While the Germans may be credited for the many advances in mine techniques, the British laid mines *en masse* for the defence of the homeland after the evacuation of the British Expeditionary Force at Dunkirk in June 1940. Military planners turned to mines to assist in the defence of Britain against a possible amphibious invasion.[63] Strong beach defences and obstacles were intended to reduce the number of forward troops and increase the numbers available for a mobile reserve. Training manuals devoted specifically to mine warfare emphasised that while all mines were considered dangerous to movements by troops, they were not to be totally relied on against enemy personnel.[64] The casualties and damage inflicted were merely a means to an end.[65] As the possibility of a German invasion receded, close to 350,000 mines had been laid on the south and east coasts of England in about 2,000 minefields.[66]

50. In April 1940, the British colony of Kenya came under threat from neighbouring Italian Somaliland and Abyssinia. However, the Italians fought primarily on the defensive and provided the Allies with their first taste of mine warfare. The Italians used barmines (crudely manufactured wooden AT mines) on roads to cause damage to Commonwealth armoured cars and antipersonnel booby traps against dismounted troops. During the East African campaign, Italian mines were never a major concern, although the potential was beginning to be realised.[67]

51. The North African campaign signalled a breakthrough in mine warfare. Before 1941, mines played a peripheral role in combat and had a limited role in defining the outcome of a military campaign. In North Africa, landmines were not merely important, they dominated the course of operations. Previously, the Germans had not used mines in any quantity, but in North Africa, they began to use them on a vast scale. Mines were laid in the thousands, and when the situation developed, in the hundreds of thousands.[68]

52. The featureless terrain and the use of armoured formations created the ideal conditions for landmines to be used. Soldiers became "mine aware," breaching drills were devised, clearance techniques were tested in battle and commanders included mines in military planning. During the first British advances against the Italians in Libya, mines were met in considerable numbers around defensive positions. Since formal clearing methods were not developed, the first sighting of a mine was when soldiers uncovered one,

---

[62] Mike Croll, p. 43.
[63] Basil Collier, *The Defence of the United Kingdom*, (London, Her Majesty's Stationary Office, 1957).
[64] War Office, *Anti-Tank Mines*, No. 40, (London, 1940).
[65] War Office, *Field Engineering, Part IV: Booby Traps*, (London, 1941), p. 1.
[66] Mike Croll, p. 54.
[67] Mike Croll, p. 55-56.
[68] James Lucas, *War in the Desert: The Eighth Army at Al Alamein*, (Toronto, Musson, 1982), p. 113.

"often under enemy fire and with their own officers demanding rapid progress to maintain the momentum of an attack"[69].

53. After the Afrika Korps arrived, Allied advances were reversed and improvised mines were used to cover the withdrawal. Despite the use of mines, superior German tactics eventually overwhelmed Allied forces. Unlike the Germans, the British made no provisions for booby trapping their AT mines and used few AP mines. British minefields that surrounded defensive positions became known as "mine marshes", but were not covered with direct fire support. Because the British used few AP mines, German armoured crews were able to dismount and clear lanes in front of their tanks.[70]

54. Field Marshal Erwin Rommel felt that the British lines at Gazala and Tobruk had been planned with great skill: "It was the first time that an attempt had been made to build a line of this kind so far into the desert. Some 500,000 mines lay in the area of these defences alone"[71]. The British constantly improved their fortified positions, mainly by the establishment of extensive minefields throughout the defended areas. Although the basic British defence plans were essentially a "second best solution" in terms of mechanisation, Rommel acknowledged that "the skilful construction of their defensive works make their line a very though nut to crack"[72]. By the battle of Alam El Halfa in 1942, British minefields were extensive. In order to hinder and canalise enemy movements, the AT and AP minefields were complemented by aerial bombing and artillery concentrations that worked to slow the progress of the Germans.[73] Although little data exists on the effectiveness of AP mines, their widespread use reflected the attempt to maximise the capability of land forces at minimum cost.[74]

55. At El Alamein, with dwindling supplies and no reinforcements, Rommel used 500,000 mines (96% of which were AT mines) to wear down the Allied advance. In placing the minefields, particular care was taken to ensure that the static formations could defend themselves. The vast numbers of mines were built into a larger scheme of defence. The defensive system at El Alamein was based on enormous defensive minefields (so-called Devil's Gardens) some five miles deep and covered by machine guns, mortars, and anti-tank guns.[75] The purpose was to bring maximum firepower to bear on the attacking force as it struggled through the minefields. Here, a model of defence in depth was created against an attacking force of superior numbers by using an intense concentration of mines. Rommel "wanted to ensure that the work of clearing the minefields proceeded at the slowest possible speed and not until after our outposts had been eliminated. Most of the mines available in Africa were unfortunately of the anti-tank type, which infantry could walk over without danger"[76].

---

[69] Mike Croll, p. 57.
[70] Mike Croll, p. 59.
[71] B.H. Liddell Hart (editor), *The Rommel Papers*, (London, Collins, 1953), p. 194.
[72] *The Rommel Papers*, p. 195.
[73] John Strawson, *The Battle for North Africa*, (London, B.T. Batsford, 1969), p. 128.
[74] Mike Croll, p. 59.
[75] Stephen W. Sears, *The Desert War in North Africa*, (New York, Harper and Row, 1967), pp. 96-97.
[76] *The Rommel Papers*, p. 300.

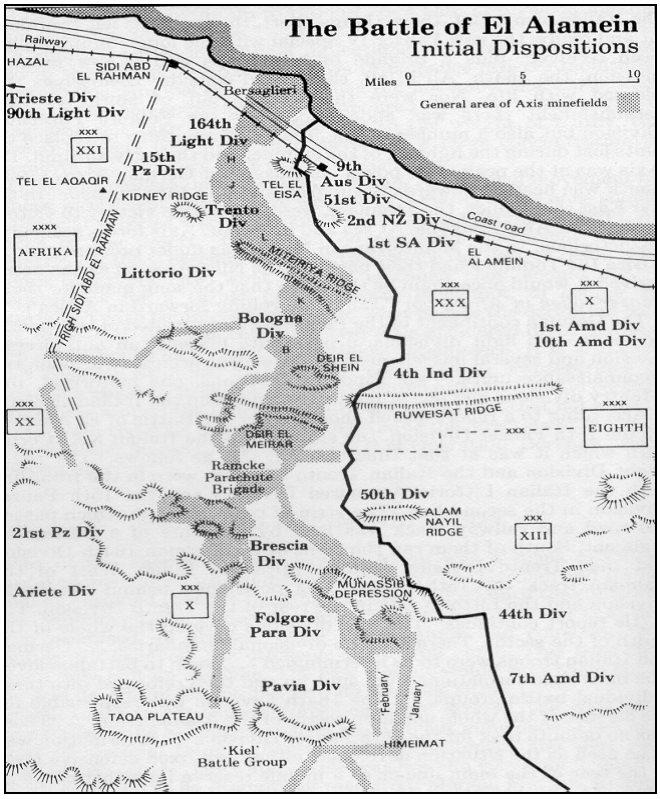


Figure 1: General Area of Minefields at El Alamein

56. The British placed major emphasis on the problem of passing men and vehicles through minefields: "It was this single problem which caused more trouble and recrimination than any other in the whole battle"[77]. Attempts to breech German defences proved difficult and costly. As the urgency of battle increased, difficulties were experienced in breaching paths through the minefields under constant harassment from enemy fire. Although mines (AT in particular) proved to be an obstruction that bogged down the attack and caused casualties when vehicles were struck, forcing soldiers to lift them by hand, the Allies eventually achieved a breakthrough.[78] Although AP mines had a minor role, the British forces had to develop tactics and procedures to cope with the mines.

57. On their withdrawal to Tripoli, the Germans used extensive teams of infantry, tanks, anti-tank guns and minefields to fight delaying actions. To offset their weaknesses, approach routes were heavily mined and covered by infantry and artillery, with a mobile reserve kept in each sector.[79] As the Germans withdrew, the newly arrived Americans were bogged down because troops encountered "mines and demolitions on such as scale as to suggest a new weapon in warfare"[80]. An important lesson that was drawn from the Allied advance to Tripoli in the face of a determined enemy was the need for engineer units on a liberal scale. Demining, however, placed additional demands on engineer resources already fully committed.[81] Mine detectors were shown to be essential equipment, but the types in use did not completely defeat wooden-box mines. Because the Germans sowed

---

[77] John Strawson, p. 135.
[78] C.E. Lucas Phillips, *Alamein*, passim., (London, Heinemann, 1962)
[79] George F. Howe, *The United States Army in World War II, The Mediterranean Theater of Operations: Northwest Africa: Seizing the Initiative in the Wes*, (Washington, Department of the Army, Center for Military History, 1957), p. 402.
[80] Alfred M. Beck, Abe Bortz, Charles W. Lynch, and Ralph F. Weld, *The United States Army in World War II, The Technical Services: The Corps of Engineers: The War Against Germany*, (Washington, Department of the Army, Center for Military History, 1985), p. 100.
[81] DHH 143.3F14009 (D8), "Summary of Engineer Lessons from Benghazi - Tripoli Advance".

AP mines in road craters, filling them by hand was very hazardous. Light armoured protection against S-mines was recommended.[82]

58. Behind the covering screen of thousands of mines, the Germans withdrew from Eastern North Africa unmolested by ground troops. During the retreat, the Germans were hardly concerned with relocating mines, so they scattered and booby-trapped them indiscriminately. Sporadic mine laying was an unpleasant nuisance for the pursuing Allies. Such methods "had a heavy psychological effect on attacking troops and delayed the advance more effectively than pattern mining could have"[83]. Many soldiers had personal encounters with AP mines. While a New Zealand officer positioned his company, he could not identify numerous explosions in the area, and on investigating found several men killed and wounded: "It was then that I realized we were in the middle of a concentration of antipersonnel mines. A cold shiver ran down my spine…every step I took I expected to be my last"[84].

59. When the Germans mounted a formal defence during the retreat, AP mines were used effectively. In Tunisia during the closing stages of the North African campaign the minefields were particularly deep and numerous and were covered by all types of fire. They included a high proportion of non-metallic AP mines that were practically impossible to locate with mine detectors.[85] A large part of the combat engineers' time was devoted to laying, lifting, and clearing mines, often to the neglect of their other work.[86] At Medenine, hundreds of allied soldiers were killed or wounded in the attack, mainly by AP mines. The linking of charges, designed to defeat countermeasures, contributed to the effectiveness of German mine use.[87]

60. Although AP mines were not a prominent feature of warfare in North Africa, the continual threat of AP mines created an additional burden on the Allies. Although by themselves they never threatened to change the course of the campaign, AP mines influenced the pace of the battle when used in conjunction with AT mines. The Germans used S-mines and trip wires not only as protection, but also as warning devices to their posts in the hills.[88] Mines were considered in military planning because "they caused concern and casualties to [armies] as yet not fully acquainted with this form of warfare"[89].

61. On the Eastern Front, both the Soviets and Germans realised the significance of mines and used them on an organised scale by the millions. Throughout the course of the fighting, both sides laid masses of mines. The Soviets had experimented with mines during the inter-war period, but only had about 1 million AT mines available in 1941. In addition to their own designs, they copied or refined the more reliable and battle-tested German mines. Many improvised mine types were encountered.[90] By the end of the war, the Soviets developed twelve types of AP mines.[91]

62. The Soviets showed a predilection towards large minefields, and were the first to

---

[82] DHH 143.3F14009 (D8), "Summary".
[83] Alfred M. Beck *et. al*, p. 101.
[84] John Strawson, p. 173.
[85] Brigadier-General B.K. Young, "The Development of Land-Mine Warfare", *The Army Quarterly*, (January-February 1945), p. 46.
[86] Alfred M. Beck *et. al*, p. 103.
[87] Mike Croll, p. 64.
[88] B.K. Young, p. 43.
[89] B.K. Young, p. 42.
[90] Major-General Hellmuth Dorn, "Engineers and Technical Services", *The Soviet Army*, B.H. Liddell Hart, Ed., (London, Weidenfeld and Nicholson, 1956), p.369.
[91] Mike Croll, p. 66.

use mines as offensive weapons. Groups of partisans operating behind enemy lines frequently laid mines as obstacles to disrupt supply and damage morale. The Germans suffered losses from mines and ambushes using mines gave courage to the partisans and raised their prestige among the local people.[92] But the principal use of mines by both sides lay in defence. For the defence of AT minefields, AP mines were set along approaches and laid in the minefield itself. Many variants of minefields were used to puzzle the Germans, including the use of AT mines in combination with AP mines, and the use of dummy mines, the use of mines with anti-lift devices and booby traps.[93] German General Gunther Blumentritt recalled: "Excellent positions in great depths were built in the shortest of time, often with the help of the civilian population. Minefields played a great part"[94]. Indeed, with adequate forces, mines "were often the sole obstacle that could be established in the wide plains of Russia"[95].

63. The minefields laid by the Soviet engineers in the Kursk salient played a major role in the defence. The Soviets planted over 1 million AP and AT mines, erected 500 miles of barbed-wire entanglements and built a myriad of obstructions. On average, the estimated minefield density was 2,400 AT and 2,700 AP mines per mile of front, about one every foot. The great density of mines won vital time for the defenders when rushing reinforcements to those sectors most threatened by a German breakthrough. The Soviets considered mines "a mass and indispensable weapon for all ground troops"[96].

64. The Soviets were more affected by surprise and the unusual, than by concern for high casualties. They attacked frontally with enormous expenditure of men and materiel, and experienced difficulty in penetrating German minefields when the High Command wanted to advance at all costs. In mid-July 1942 on the Voronezh salient, the Soviets sent out numerous patrols to determine the boundaries of German minefields (some patrols suffered casualties from AP mine explosions).[97] While the Soviets demonstrated skill in their disarming of German AP mines, engineers were not given time to open lanes for advancing infantry, and troops were driven forward ruthlessly through minefields, irrespective of casualties. Such tactical shortcomings often misfired. In 1943, a German report stated:

> Heavy casualties were also inflicted on strong enemy assault units which entered the minefield. Even when the position of these minefields became known, the Soviets did not resume their attacks either with tanks or infantry, so that our infantry enjoyed a substantial respite. The success is to be ascribed exclusively to the effect of mines.[98]

65. The Soviets' way of waging countermine warfare included the use of cattle, dogs, prisoners of war, refugees and infantry to clear paths through uncharted minefields. In some instances, attacks were even preceded by soldiers marching shoulder to shoulder across minefields, the ranks broken when mines exploded to kill and wound those around

---

[92] Captain N. Galay, "The Partisan Forces," In *The Soviet Army*, pp. 154-155, 164.
[93] "A Brief Review of the Tactical Use of Antitank Defence Assets", *Documents on the Use of War Experience: Volume I, The Initial Period of War, 1941*, (London, Frank Cass, 1991), pp. 25-26.
[94] General Gunther Blumentritt, "The State and Performance of the Red Army, 1941", *The Soviet Army*, p. 137.
[95] Hellmuth Dorn, p. 370
[96] Robin Cross, *Citadel: The Battle of Kursk*, (New York, Sarpedon, 1993), p. 131.
[97] US, Department of the Army, *Small Unit Actions During the German Campaign in Russia*, Army Pamphlet 20-269, (Washington, 1953), pp. 163-165.
[98] Hellmuth Dorn, p. 372.

it. Commissars or officers who followed the troops shot those who hesitated.[99] During frequent discussions with the Supreme Allied Commander Dwight Eisenhower on the campaigns of the war, Marshal Zhukov, Commander in Chief of the Soviet forces, offered a highly illuminating description of the Soviet method of attacking through minefields:

> When we come to a minefield our infantry attacks exactly as if it were not there. The losses we get from personnel mines we consider only equal to those we would have got from machine guns and artillery if the Germans had chosen to defend that particular area with strong bodies of troops instead of with mine fields. The attacking infantry does not set off the vehicular mines, so after they have penetrated to the far side of the field they form a bridgehead, after which the engineers come up and dig out channels through which our vehicles can go.[100]

66. Regardless of the heavy casualties sustained in running over minefields, the Germans were still unable to repulse the Soviet onslaught. The Germans maintained a dogged defence from 1943 and gradually retreated until they surrendered in 1945.

67. In Sicily, mines were a nuisance, but rarely a menace. No AP mines were found on the beaches themselves where, as on observer remarked, they would have been "horribly effective"[101]. In the dunes and cover, AP mines became more plentiful and deliberate. They caused delay and casualties, particularly when a stand was made near Catania and along the road from Mount Etna to Messina, where the very nature of the terrain lent itself to land mines. The Germans made full use of natural opportunities given to them to create obstacles on the Italian mainland, where the valley terrain was admirably suited for stubborn defence. The landings on the beaches were practically mine-free, and even at Anzio few were discovered.[102]

68. As the Allies advanced northwards to the Gothic Line, they ran into increasingly dense and systematic minefields that included familiar and unfamiliar varieties of AP mines, such as those with delayed detonators and improvised charges. To the end of the Italian campaign, each successive German fortified line had elaborate mine defences. The Germans frequently sowed mines without pattern and used confusing methods, distances and depths. The scale of AP mining increased as the campaign progressed. They were planted in places from vineyards to buildings, where soldiers would take refuge, to entire valleys, and even in the wallets and bodies of dead soldiers.[103]

69. Unlike the desert, in Italy the Germans were able to use the terrain and natural obstacles to their advantage to limit Allied offensive operations. Allied engineers emphasised that mines were a normal risk of war, and passed on proper techniques for detecting and clearing mines to ease the fear of the threat. However, many American troops were not adequately trained for mine warfare: "Infantrymen retained the dread of mines that had been so marked in North Africa…[many] came to the battlefield without even having seen the devices they were to unearth and disarm"[104].

---

[99] Robin Cross, p. 63.
[100] Dwight D. Eisenhower, *Crusade in Europe*, (New York, Doubleday, 1948), pp. 467-468.
[101] Alfred M. Beck, *et. al*, p. 130.
[102] B.K. Young, p. 47.
[103] Alfred M. Beck, *et. al*, p. 181.
[104] Alfred M. Beck, *et. al*, pp. 182, 564.

70. Other problems in mine detection were encountered during the Italian campaign. The SCR-625 Mine Detector was a valuable piece of equipment for detecting mines, but the fact that it was not waterproof and quite fragile limited its usefulness. With the increasing number of non-metallic German AP mines, mine detectors became less dependable and the prod more important. Wooden AP Schümines were difficult to spot, since only the fuse was metal. Box Mines (Holzmines) made of wood were particularly difficult to detect. Canadian Engineers noted that there were not too many booby-traps, although the Germans sometimes sneaked in and laid mines in cleared areas. From the numerous occasions when obstacles and minefields held up the infantry, opportunities were lost for rapid removal and surprise.[105] Italian soil also contained heavy mineral deposits and large concentrations of shell fragments, scrap metal and other artefacts buried over the ages caused confusion. In areas sown with S-mines, bulldozers were frequently used, with operators wearing body armour for protection. But in many cases when they struck the AP and AT mines, the operators were thrown from their seats. AP mines were too small to damage bulldozers seriously, but the Germans placed them in areas inaccessible to bulldozers. Schümines were often interspersed with S-mines in open fields or along paths.[106]

71. Checking and clearing AP mines were slow and careful processes that required many men and involved risks even when there was no enemy fire. Often, a large area in Italy contained only a few AP mines, but the numbers bore little relation to the time spent checking and clearing. For instance, the 10th Engineer Combat Battalion (3d Division) in an area north of Naples suffered 57 casualties, including 15 deaths, in clearing 20,000 mines of all types during a period of sixteen days. Much of the work had to be done under fire from artillery, machine guns and mortars. Casualties were inevitable. The 10th Engineer Combat Battalion had 90 detectors, but its use was limited because many were unserviceable or the Germans could often hear the hum of the detector, especially at night.[107]

72. New, more sensitive detectors were tested to clear both metallic and non-metallic mines, but research and development projects were often rejected or cancelled because of undependable or unsatisfactory results.[108] Rifled grenades that propelled primacord across AP minefields were able to cut trip wires and detonate Schümines. Segments of explosive pipes (or Snakes) were effective only over flat, heavily mined ground. They were susceptible to the elements, slow to build, difficult to transport and vulnerable to artillery fire and mine detonations.[109]

73. All of this combined to make it difficult to move combat troops forward. During the third week of August 1944, the Canadians tested the adequacy of the unfinished Gothic Line, which was shielded by minefields (72,517 AT and 23,172 AP mines). The Princess Patricia's Canadian Light Infantry (PPCLI) and The West Nova Scotia Regiment shared an agonising experience, and struggled through a field of AP mines. They resorted to single file and accepted casualties as they went. Though delayed, the outcome was still

---

[105] Colonel A.J. Kerry and Major W.A. McDill, *The History of the Corps of Royal Canadian Engineers, Volume II, 1936-1946*, (Ottawa, Military Engineers Association of Canada, 1966), pp. 148, 206.
[106] Alfred M. Beck, *et. al*, p. 181.
[107] Alfred M. Beck, *et. al*, pp. 182-183.
[108] DHH 115.41013 (D166), " Army Technical Development Board, Project no. 5019", 15 July 1943.
[109] Alfred M. Beck, *et. al*, p. 183.

successful.[110]

74. The Allies were challenged by German use of mines and found themselves improperly trained to deal with the threat. At Cassino in January 1944, the German defences were formidable and heavily mined. The US Fifth Army encountered a mine belt more than a mile in length. German patrols interrupted mine-clearing operations and placed more mines so that passage became difficult. Minefields, fog and German fire contributed to the disorganisation and defeated the attempts to make a crossing of the Rapidio River.[111]

75. When the Allies were on the defensive at Anzio, they were forced to use extensive minefields for the first time. They laid many AP and AT mines at night in many places with no natural features, planted mines haphazardly and made inaccurate and incomplete records. Many of the minefields proved extremely sensitive to detonation by heavy German fire and resulted in "a marked increase in casualties"[112]. Since no standard method of planting mines developed, the Allies continued to make serious mistakes. AP mines were laid too close together and in front of protective wire, not around AT mines. These efforts proved time-consuming. At Anzio, a platoon of the 109th Engineer Combat Battalion devoted 240 man-hours to planting 2,444 AT and 199 AP mines, with a separate squad taking 96 man-hours to mark the fields.[113] As the beachhead stabilised, haphazard methods became more deliberate and careful, with fields being marked and recorded.

76. In response to the fears of an Allied invasion of Europe, the Germans embarked upon an elaborate scheme of defence. As a start on building the Atlantic Wall, Rommel emphasised:

> I want antipersonnel mines, antitank mines, antiparatroop mines…I want some minefields designed so that our infantry can cross them, but no enemy tanks. I want mines that detonate when a wire is tripped; mines that explode when a wire is cut; mines that can be remotely controlled and mines that will blow up when a beam of light is interrupted.[114]

77. Rommel, predicting that the Allies would launch an invasion to secure a port, felt that the best possible chance for success lay at confronting the Allies on the beaches. No matter how many millions of landmines were laid, Rommel felt that the fixed defences could only hold up the assault, not turn it back, which would require a vigorous counterattack by mobile infantry and panzer divisions. Since coastal artillery was never adequate or adequately protected, there was a huge effort made in mining and fortification. In most places where a landing was possible, several parallel minefields were laid, each several miles wide, forming a zone up to five miles deep. The minefields covered fortified strong points, sometimes including stationary tanks. To deceive the invader, dummy positions were also prepared.[115]

78. As a result of his experiences in North Africa, Rommel believed that large minefields would provide conditions in which German divisions would be able to defeat

---

[110] G.W.L. Nicholson, *Official History of the Canadian Army in the Second World War: The Canadians in Italy, 1943-1945,* (Ottawa, Queen's Printer, 1956), pp. 497-516-517.
[111] Alfred M. Beck, *et. al*, p. 190-191.
[112] Alfred M. Beck, *et. al*, p. 197.
[113] Alfred M. Beck, *et. al*, pp. 197-198.
[114] Stephen E. Ambrose, *D-Day, June 6, 1944: The Climactic Battle of World War II*, (New York, Simon and Schuster, 1994), p. 64.
[115] David Fraser, *Knight's Cross: A Life of Field Marshal Erwin Rommel*, (London, Harper Collins, 1993), p. 455.

the Allied forces. For the first stage, Rommel felt that "10 mines a yard will be required, making a total for the whole of France of 20,000,000 mines. For the remainder of the zone (depth of 8000 yards), the defence of France will require in all some 200,000,000 mines"[116]. Up to May 1944, 4,193,167 mines were laid, most of them on Rommel's initiative. German minefields contained mines of all kinds, and Rommel thought that they would likely be highly effective: "If the enemy should ever set foot on land, an attack through the minefields against the defence works sited within them will present him with a task of immense difficulty"[117].

79. Throughout the war, mines had caused the Allies a considerable deal of anxiety. Eisenhower admitted, "German minefields, covered by defensive fire, were tactical obstacles that caused us many casualties and delay"[118]. Allied preparations for D-Day included a considerable amount of effort to overcome German minefields. The most promising solutions of were tanks with flails, rollers and ploughs capable of unearthing mines. For the actual invasion, the Americans preferred detectors, bayonets and Bangalore torpedoes, supported by armoured bulldozers. The British supplemented such breaching methods with flails and rollers.[119]

80. The assault at Normandy on D-Day had to cross a wide cross-section of beach obstacles from Belgian gates to landmines. On every beach that was suitable, Rommel built defences. Onshore, the defences differed to suit local terrain conditions, but the obstacles were similar along the beaches. As American soldiers from the 237th Engineer Combat Battalion followed bulldozers and pushed forward trying to get off the beach to move inland, they were forced to move forward into minefields. One said: "And suddenly they started stepping on mines, S-mines, Bouncing Betties. These mines bounced up and exploded. These men began screaming and running back to the beach with the blood just flowing"[120].

81. AP mines laid by the Germans in the area of the beaches handicapped early operations. On Omaha, an assault by the 115th Regiment was stalled by a rumour through the ranks that American mine detectors could not locate German mines. This caused casualties and many delays, but overall the casualties due to AP mines were light. For example, the 8th and 22nd Regiments had 12 men killed, 106 wounded, and the 12th Regiment had 69 casualties, nearly all caused by S-mines.[121]

82. D-Day was a resounding success, with nearly all objectives attained. The millions of AP mines that reinforced the Atlantic Wall held up the Allies in places, but they did not stop the invasion. Rommel's inability to complete deep minefields along the Atlantic Wall probably contributed to the ineffectiveness of German resistance. German AP mines were overwhelmed by a superior concentration of force and firepower.

83. As the Allies advanced across Western Europe, the Germans used an increasing number of wooden, glass, clay and plastic mines to avoid detection and cause delay. During their retreat, the Germans left behind some of the most extensive minefields encountered on the Continent, causing allied mine removal teams to work in prolonged

---

[116] *The Rommel Papers*, p. 457.
[117] *The Rommel Papers*, p. 458.
[118] Dwight D. Eisenhower, p. 467.
[119] Mike Croll, pp. 75-77.
[120] Stephen E. Ambrose, 1994, pp. 281-282.
[121] Stephen E. Ambrose, 1994, pp. 462, 292.

combat conditions. The Germans planted huge minefields protected by machine gun nests and concrete pillboxes. These defences proved effective. When an American infantry battalion attempted a reconnaissance mission in July 1944, the troops ran into "mine studded fields strung with checkerboard patterns of piano wire about a foot off the ground and the booby traps set to blow off a leg any time you stepped on the strands"[122]. After futile attempts to find the limits of mined areas, the Infantry of the 90th Division was forced to attack the Germans through AP minefields, taking their losses along the way. As the Germans retired to new lines of defence, AP mines slowed the infantry.[123] Following the retreat of the Germans, a dismal pattern repeated itself: "Infantry would get within a few hundred yards of the objectives, and then they would run into mines. A man would hit a trip wire, there would be a click, then the mine would spring out of the ground and explode five or six feet in the air, spraying metal splinters"[124]. On occasion, companies approached as close as a hundred yards to objectives before being repulsed by defensive fire augmented by minefields.

84. In the Pacific theatre, the dispersed style of fighting and lack of experience with the weapon meant that AP mines were not used as extensively in the West. Nevertheless, the geography (with its dense vegetation and narrow inland routes) and method of combat lent themselves to mine warfare.[125] The Japanese tried to install and scatter mines as a hindrance to advancing troops, but the US Army was able to either remove or quickly demolish them using bulldozers and tanks. The few mines that were found in the assault on Saipan revealed "a complete lack of thought" with regard to their placement, concealment and tactical use.[126] Japanese hand grenades, mortar ammunition and most types of artillery ammunition were used for booby traps or mine purposes. Some minefields were arranged in single, straight rows, parallel to the beaches and spaced at intervals of 10-15 feet apart.[127] In the Philippines, landing beaches were heavily mined, but they were rapidly cleared. As was often the case, Japanese AP minefields were hastily prepared, improvised and ineffectual. Little or no effort was made to camouflage the mines. In the Leyte campaign, Japanese mines played an insignificant role. They were laid with no real sense and found in a number of places on the beaches. In the central part of the island, a more considerable number of AP mines were found, but they were too poorly concealed to be effective, and played no appreciable role in the campaign. Although destroying the Japanese proved tedious against mounting resistance, in general Japanese AP mines were more of a nuisance than anything else and did not slow the Allied advance.[128]

85. For the purpose of evaluating the relative effectiveness of different weapons as casualty producing agents, data was obtained by the US Army Medical Service on the Bougainville Island Campaign, which occurred from 15 February to 21 April 1944. In general, the number of battle casualties produced by a weapon depends on the type of warfare, the nature of the terrain, the number of weapons employed and the training and tactics of the opposing forces. Thus, the measure of the operational effectiveness of a

---

[122] Alfred M. Beck, *et. al*, p. 369.
[123] H.M. Cole, *The United States Army in World War II, The European Theater of Operations: The Lorraine Campaign*, (Washington, Department of the Army, Center for Military History, 1950, pp. 401-402.
[124] Charles B. MacDonald, *The United States Army in World War II, The European Theater of Operations: The Siegfried Line Campaign*, (Washington, Department of the Army, Center for Military History, 1963), p. 575.
[125] Mike Croll, p. 73.
[126] Karl C. Dod, *The United States Army in World War II, The Technical Services: The Corps of Engineers: The War Against Japan*, (Washington, Department of the Army, Center for Military History, 1957), p. 497.
[127] DHH322.009 (D167), "Japanese Mines and Booby Traps", July 1943-1945.
[128] Karl C. Dod, pp. 524-525, 538-539, 620.

given weapon (such as AP mines) varies according to the circumstances under which it is used. The effectiveness depends not only on the number of casualties it produces, but also on the ratio of the killed to wounded and the severity of the wound. In certain situations, the most effective weapons may temporarily disable a great number of enemy troops and allow the capture of a particular objective or win a battle.

86. The battle casualties included in the study were derived from a total strength of 49,363 (excluding Navy and Marine personnel and civilians). There were 2,335 US battle casualties—combatants who were killed or wounded by Allied and enemy weapons. Of these, 1,788 casualties were either killed in action or sustained wounds which necessitated hospital treatment (547 were lightly wounded and returned to duty). On the enemy side, an estimated 8,527 Japanese soldiers were killed in action out of 27,000 troops (including Army and Navy), approximately 10,000 of which were directly involved in combat.[129] Control of the air, the use of tanks, and superior firepower in defensive positions, in addition to the greater and more effective concentrations of artillery fire, were the chief factors accounting for the large number of the Japanese dead.[130]

87. Difficulties inherent in jungle warfare precluded the use of artillery in close support of attacking Japanese infantry. For this purpose, the Japanese principally relied on mortar fire and the results indicate the highest percentage of casualties were due to mortars.[131] Table 1 gives a breakdown of the casualties during the survey period.

Causative Agent	**Casualties**		**Dead**		**Living**	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Rifle	445	24.9%	143	32.1%	302	67.9%
Machine-gun	151	8.4%	87	57.6%	64	42.4%
Artillery	194	10.9%	44	22.7%	150	77.3%
Mortar	693	38.8%	82	11.8%	611	88.2%
Grenade	224	12.5%	14	6.3%	210	93.8%
Mines	34	1.9%	13	38.2%	21	61.8%
Miscellaneous*	47	2.6%	12	25.5%	35	74.5%
TOTAL	1788	100.0%	395	22.1%	1393	77.9%

* Miscellaneous includes air bombs, pistols, powder explosions and flares, bazooka, and bayonet.

Table 1: Distribution of US Battle-Casualties by Weapon, Bougainville, 1944

88. A comparison of the incidence of casualties caused by different weapons shows that mines accounted for less than 2%, the lowest of any category. The relative lethal effect of the mine was quite high, with a value of 38.2%, the second highest rating next to the machine gun. However, of the 34 mine casualties, US mines produced 33, with one dying as a result of Japanese weapons. It should be noted that the Japanese sometimes infiltrated

[129] US Army, Medical Department, *Wound Ballistics*, (Washington, Office of the Surgeon General, Department of the Army, 1962), p. 345.
[130] US Army, *Wound Ballistics*, pp. 309-310.
[131] US Army, *Wound Ballistics*, pp. 290-291.

Allied lines, reoccupied their positions and forced the Americans to counter-attack. The deadly effectiveness of landmines was demonstrated, with soldiers suffering a multiplicity of wounds. In all of these instances, the victim either stepped directly on the mine or was injured at close range by having tripped on a mine wire.

89. During the Second World War, AP mines had become a regular feature of warfare, as opposed to the more peripheral role in the pre-1939 period. AP mines demonstrated their utility in delay inflicted on advancing forces. In combination with other defences, they were able to help economise the defence and impose casualties on the attacker. Since the methods of clearance were not fully satisfactory, the initiative remained with the defender. As well, the ability to impose a psychological and moral burden on advancing forces, especially the fear of the unknown and an inability to fight back, made the AP mine a disturbing weapon.[132]

LIMITED AND INSURGENCY WARS

90. By the end of the Second World War, mines played a role in defence for all armies and many types of mines had been developed for use in combat. In many respects, the war confirmed the use of AP mines to cause casualties, affect morale and attempt to reduce mobility. Since 1945, mine designs have concentrated on effectiveness, size, detectability, logistical effort and speed of laying. Modern refinements in technology, including synthetic materials and electronics, have contributed to the evolution of AP mines. Rapid advances in technology outpaced AP mine countermeasures and made locating and removing buried ordnance more difficult.[133]

THE KOREAN WAR

91. AP mines have been used extensively in a number of limited conflicts. The Korean War (1950-1954) offered the first opportunity for the lessons of the Second World War to be applied. Both the United Nations (UN) and South Korea forces used mines to cover their withdrawal and to enhance defences against communist North Korea and China. As in the Italian and Pacific theatres in WWII, the mountainous terrain in Korea restricted movement, and the valleys and passes were obvious places in which mines would be laid.[134]

92. Initially, the UN and South Korean forces were unable to use mines as a method of defence against the advancing North Koreans because there were none in Korea. The South Korean troops had no formal training in mine warfare. US officers were of the opinion that a few well placed AT mines would have stopped entire road bound armoured columns, and be more effective in disabling a tank than the Korean "body contact squads"[135]. Major Richard Crawford of the Korean Military Advisory Group commented that "the necessity for some type of land mine was becoming increasingly apparent"[136]. When mines became available, hard-pressed infantry commanders insisted on several

---

[132] Mike Croll, p. 81.
[133] Mike Croll, p. 97.
[134] Mike Croll, p. 97.
[135] Roy E. Appleman, *The United States Army in the Korean War: South to the Naktong, North to the Yalu, June-November 1950*, (Washington, Offices of the Chief of Military History, 1961), p. 72.
[136] Major Richard I. Crawford, "Learning by Doing". In Captain John G. Westover, *The United States Army in the Korean Conflict: Combat Support in Korea*, (Washington, Combat Forces Press, 1955), p. 24.

occasions that undefended minefields were to be laid in places where there were gaps in their lines. Under the pressure of hasty withdrawal and the stress of retreat, mine laying sometimes degenerated into pitching them from the back of a moving truck. Allied forces discovered that AP mines were double-edged weapons, in the words of Lt Sam D. Starobin of the 65th Engineer Combat Battalion: "Properly employed they can be a strong instrument of defence. Improperly used they are a menace"[137].

93. Mines were used conventionally for defence, but the marking and recording of minefields was generally poor. Indeed the failure to record minefields was a serious problem in Korea. In unguarded fields, the communists found it easy to relay landmines in areas thought to be safe, to cause Allied casualties.[138] The Allies also had a number of their personnel killed by their own AP mines. In one incident, Australian forces suffered fifty casualties when they unwittingly entered an unmarked, unrecorded minefield that had been laid by Canadians. This situation was caused by a common theme since AP mines were introduced on the battlefield: it is extremely tedious and unfulfilling to train on the intricacies of mine warfare. Infantry and armoured peacetime manoeuvres have a tendency to disregard minefields. Since laying and clearing mines appear so simple and repetitive, it was often felt that little or no training was required.[139] Other allies experienced some difficulty with the unorthodox Canadian methods of laying minefields, which did not seem to conform to established patterns. But the Canadian Army was not alone in committing errors when laying mines. One report noted "The standard of recording particularly has been bad throughout"[140]. The British suffered fatal accidents in their own minefields due to errors and faults in procedure. It should be noted that on many occasions when a particular operation resulted in a mine being detonated, "all ranks took cover"[141].

94. Many defensive sectors were poorly positioned and laid out, offering occupants little protection. Major Pope, a Canadian officer, felt that less use should be made of mines and more use of protective fire. In his opinion, mines made movements difficult for the attackers as well as for the defenders. A uniform defensive doctrine, whereby each battalion would develop defences according to a single plan, was not established or enforced by the Commonwealth Divisional Headquarters. Because the steep hills, terraced slopes and boggy bottoms did not allow trenches, soldiers encircled hilltops behind minefields and wire obstacles. The minefields surrounding the hilltops had only one gap, to allow access and egress for the purposes of patrolling. However, the Chinese took advantage of a limited number of roads and thick undergrowth to interdict repeated nightly patrols using their own mines. Numerous indirect fire weapons and a large number of mortars used by the Chinese caused some 52 percent of all Canadian casualties up to December 1951.[142]

95. As a result, the 1 Commonwealth Division outlined methods to be adopted for minelaying: "Minefields NOT covered by fire are of little more than nuisance value. They may cause a few casualties. They may give warning of an attack, but other methods (e.g. trip flares) are equally efficient by day and more efficient by night. By themselves,

---

[137] Lt. Sam D. Starobin, "Mines are Double-Edged Weapons", In John G. Westover, p. 23.
[138] Sam D. Starobin, p. 24.
[139] Mike Croll, p. 99.
[140] DHH 112.3E1 (D29), "Engineer Intelligence", 1945/1951.
[141] DHH 112.3E1 (D30), "Engineer Intelligence", 1949/53.
[142] David J. Bercuson, *Blood on the Hills: The Canadian Army in the Korean War* (Toronto: University of Toronto Press, 1999), pp. 6, 126, 146-147, 154.

minefields will certainly never stop an attack"[143]. There were usually insufficient mines to meet requirements and therefore minefields were often not effective. Protective minefields laid too close to well-defined forward defensive positions were unlikely to stop enemy patrols and minor probing attacks, especially if they were unsupported by heavy concentrations of fire of other weapons. There were also limitations to AP mines activated by trip wires in areas of thick foliage or trees: "AP mines laid with trip wires are liable to be set off prematurely by growing or moving foliage or by falling branches of trees, particularly under or after shell fire"[144].

96. The Chinese gathered information about US minelaying and noted the following defects: American mines and wires were easily discovered, and wires were likely to be cut by artillery fire. The Chinese interrogated local inhabitants and prisoners of war on the location of US mines. Although mine detectors were not used under fire, hand grenades, machine guns and small blocks of explosives were used to detonate discovered mines in addition to hand clearance by small groups of experienced soldiers.[145]

97. When properly employed, AP mines proved effective in disrupting enemy forces. On the defensive positions along the Naktong perimeter, both AT and AP mines were laid. On one of the defended AP fields, 113 enemy casualties were counted in a two-hour attack. Crawford pointed out that "this action raised the morale of our fighting forces, and at the same time created a supply problem: we couldn't get enough mines"[146]. The Chinese and North Koreans adopted the Soviet method of running soldiers over minefields without regard for casualties. While AP minefields were not capable of stopping such massed attacks, they reduced the number of people that reached the objective, and prompted the US military to call for "light antipersonnel mine that is a guaranteed casualty producer"[147]. This led to the production of the American M14 pressure mine (or toe-popper), the M18 Claymore directional fragmentation mine and the British No. 6 "carrot mine" to fill the void in capability. Hurling hundreds of steel ball bearings, Claymore-type mines detonated by tripwire or electric command were particularly suited to attrition warfare.[148]

98. After the UN forces halted the Chinese offensive in the spring of 1951, the use of mines became a feature in front of defensive positions in the narrow valleys. AT mines would stop tanks and the infantry would try to remove them. At such times, flares illuminated the scene and pre-registered mortar fire was brought down on an immobilised enemy with fatal results.[149] Patrol bases established in front of the main battle positions, afforded the UN forces depth to the defensive line. Trip flares, mines, barbed wire, and planned fire made them "a difficult position to penetrate"[150]. However, the Chinese were still able to push through the wire entanglements and minefields into the Allied positions. North Korean positions were protected by thick minefields and strongly built bunkers. They were able to wait in their bunkers until UN air and artillery support ceased, and the soldiers advanced. In combination with bunkers and effective artillery fire, mines played a role in aiding to strengthen the communist defences.

---

[143] DHH 112.3E1 (D30), "Engineer Intelligence", 1949/53.
[144] DHH 112.3E1 (D30), "Engineer Intelligence", 1949/53.
[145] DHH 112.3E1 (D30), "Engineer Intelligence", 1949/53.
[146] Richard I. Crawford, p. 25.
[147] Mike Croll, p. 99.
[148] Mike Croll, p. 100.
[149] Roy E. Appleman, pp.
[150] Walter G. Hermes, *The United States Army in the Korean War: Truce Tent and Fighting Front*, (Washington, Offices of the Chief of Military History, 1966), p. 85, p. 76.

99. The shrewd use of mines allowed the South Korean 6th Division to straighten its line along the Naktong perimeter and shift a maximum number of troops to the offensive. Engineers placed AT mines on the roads at points where tanks stopped to fire, and activated them by placing AP mines underneath them. AP mines were also placed in a chevron pattern and along the shoulders of roads, with trip wires laced across, to take advantage of the practice of the North Koreans of surrounding their tanks with engineers to clear AT mines and infantry to prevent close-in attack. When the North Koreans attacked, entire companies got into the first belt of mines before they hit the first trip wires and realised their predicament: "Mines exploded and men screamed. The attackers turned in panic only to kick more of the trip wires. The whole affair lasted scarcely five minutes, yet we estimated a hundred casualties"[151]. More minefields were laid as part of a trap to strengthen the South Korean defensive positions. Minefields gave the UN forces time to move and erect defensive barriers. Not only were mines used reinforce defensive positions, but they were also used successfully in an offensive capacity when troops infiltrated enemy positions and placed mines and booby traps. When the North Koreans tried to cut UN forces off, they ran into booby traps, and retreated in confusion. As the UN forces withdrew, the North Koreans attacked in waves over AP minefields that had been covered with small arms fire: "Rifle and machine-gun fire did not stop the enemy, but the mines stopped them cold. They milled around for a few moments trying to find a passage, and the automatic weapons and mines wounded or killed five hundred"[152]. The North Korean attack stopped and the UN forces were able to withdraw. UN forces had gained faith in the use of AP mines to supplement other, more lethal means of defence.

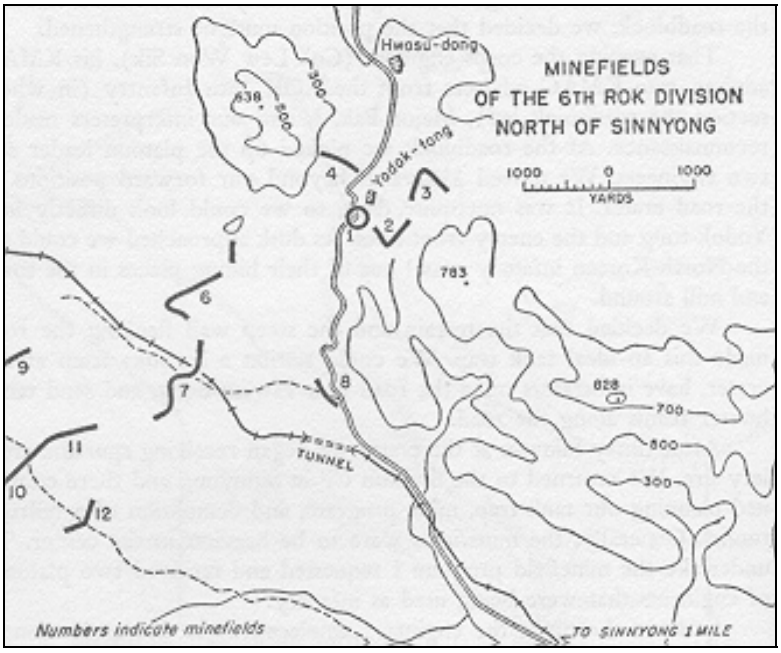


Figure 2: Use of Mines by the South Korean 6th Division

100. Wound ballistic studies during the Korean War entailed a comprehensive evaluation of the wounding potential of many types of missiles, especially small arms projectiles and fragments. Data on 4,600 wounded in action casualties with 7,773 wounds were reviewed at the Tokyo Army Hospital from 1 December 1950 to 15 February 1951.

---

[151] Major David. F. Campbell, "The Mine that Saved Sinnyong", In John G. Westover, p. 23.
[152] David F. Campbell, p. 34.

The figures in Table 2 show that fragments (approximately 92%) rather than small arms (approximately 7.5%) caused most wounds. It would appear that a bursting AP mine would have an excellent chance to produce multiple wounds with its fragmentation-spray pattern, and although a few instances were seen, most of the fragments actually missed.

Wounding Agent	Total Wounds	Percent
Fragment	6536	84.09%
Mortar	381	4.90%
Grenade	145	1.87%
Landmine	53	0.68%
Bomb	4	0.05%
Machinegun	98	1.26%
Rifle	469	6.03%
Pistol	13	0.17%
Burn	28	0.36%
Phosphorus	25	0.32%
Secondary	21	0.27%
TOTAL	7773	100.00%

Table 2: Regional Distribution of 7,773 wounds in 4,600 WIA casualties, Korea

101. A further survey of the records of 1,500 personnel killed in action was conducted at the Quartermaster Graves Registration unit, Pusan, Korea, during January 1951. Of the killed in action casualties sustained by UN forces during this period, 63% were due to enemy small arms fire, 26.9% to shell fragments, 2.8 percent to mortars, 2% to mines, 0.7% to grenades, 0.5% to artillery, and 4.1% to miscellaneous. This was in marked contrast to the results obtained from the analysis of wounded in action cases, which showed that fragments of all types were responsible for about 92% of the wounds. During the period from February-July 1952, 547 post mortem examinations were made on soldiers from American divisions along the frontline who had been killed in action. The wounding mechanism was determined in 415 of the 547 casualties (shown in table 3).[153]

Agent	Casualties	Percent
Shell fragments	278	66.99%
Small arms	106	25.54%
Mines	25	6.02%
Blast and Burns	6	1.45%
TOTAL	415	100.00%

Table 3: Distribution of 415 KIA casualties by agent (1 March - 15 July 1952), Korea

102. During the period from 24 April to 1 July 1952, the Graves Registration Service Group, Kokura, examined 346 personnel killed in action with a total of 1,346 wounds. The results are revealed in table 4, in which fragmentation from landmines accounted for 3.3% of the wounds.

[153] US Army, *Wound Ballistics*, pp. 699, 706.

Causative Agent	Number of Wounds	Percent
Fragments:		
Shell	485	36.03%
Mortar	246	18.28%
Artillery	68	5.05%
Landmine	44	3.27%
Grenade	39	2.90%
Total	882	65.53%
Small Arms:		
Unspecified	217	16.12%
"Burp" Gun	144	10.70%
Rifle	22	1.63%
Pistol	14	1.04%
Total	397	29.49%
Phosphorus	2	0.15%
Burns	65	4.83%
Total	67	4.98%
GRAND TOTAL	1346	100.00%

Table 4: Distribution of 1,346 wounds in 346 KIA casualties, April-July 1952, Korea

103. In comparing the data with the previously conducted survey, it is evident that wounds and deaths from mines increased, but very slightly. The general tactical situation had changed from a withdrawal to action consisting largely of aggressive patrolling along fixed defensive lines.

104. In terms of percentage and number of casualties, landmines ranked considerably below explosive projectile shells and small arms bullets as casualty causing agents in the Korean War with respect to US Army troops. Figures compiled by the Office of the Surgeon General show 305 killed in action (1.65%) and 2,401 wounded in action (3.32%) by landmines, out of totals of 18,498 killed and 72,343 wounded by all causative agents.[154] However, as we have seen, casualty figures alone do not reflect the impact of mines as a weapon. The psychological effect of mines and minefields goes beyond the recording of numbers, and accounts for many operations delayed, plans disarranged, and objectives unattained. The cascading effect of other factors creates an intangibility that is difficult to record statistically.

105. A study of the accompanying material prepared by the Office of the Surgeon General reveals a number of other interesting facts. There was limited use of mines in the first phases of the war, as evidenced by the lower casualties reported. The increase after November 1950 indicates an expansion of mine warfare. The relative position of landmines and booby traps as causative agents in various types of US Army ground operations were the highest in maintaining defensive lines (4.82% KIA, 7.48% WIA).

[154] Medical Statistics Agency, Office of the Surgeon General, Department of the Army, *Effects of Type of Operation and Tactical Action on Major Unit Casualty and Morbidity Experience - Korean War* (May, 1969), appendix cc. (No distinction is made to differentiate AP and AT mine casualties).

106. In general, the Korean War underscored the lessons of the Second World War.[155] Military Field Manuals written after the Korean War stressed the growing importance and broadening scale of landmines: "It is essential that all troops be adequately trained to protect themselves from enemy mines and to employ mines against the enemy"[156]. When AP mines were used properly and recorded, they provided some advantages for the defender. However, when they were used carelessly, they became a hazard to both sides. The new AP mines that were produced were more versatile. That armies had faith in the ability of mines as a barrier to shape the defensive battle was evident when the US laid a massive minefield across the 38th Parallel to deter or delay any future invasion.[157]

THE VIETNAM WAR

107. The improvements in AP mine warfare capability in the 1950s and 1960s were made not only in response to the Korean War, but also because it was felt that landmines would play a major role in stopping an assault by the Warsaw Pact on Western Europe. The Canadian C3A1 AP mine (or Elsie), offered vast improvements over its counterparts in that it was small, made of plastic, and was quick to lay. Barmines and scatterable mine systems to cover AT minefields or create nuisance minefields offered a great economy in manpower and logistical effort, but did not take advantage of electronic fuse technology.[158]

108. However, the operational deployment of mines to offer protection against a massed assault was of little use in Vietnam. The technologically superior Americans found themselves on the receiving end of mine warfare, and were at times unable to cope with the elusive Viet Cong's (VC) method of offensive AP mine warfare. The VC were able to inflict casualties and cause constant disruption with mines.

109. Aside from Chinese and Soviet-made AP mines such as the PMD 6 and PMN mines, the VC mines locally improvised mines. These were crudely manufactured devices made of tin cans discarded by American troops, bamboo tubes and unexploded American ordnance. The widespread employment of *punji* stakes was reminiscent of the caltrop and reflective of their difficulty in obtaining and manufacturing AP mines. The VC frequently resorted to stealing to make up for their lack of resources, which helps to explain the high numbers of casualties caused by American-manufactured mines. The US Commander, General William Westmoreland, described the extent of the practice:

> In an effort to preserve a portion of Phouy Tuy province, the Australians laid some 20,000 antipersonnel mines, but South Vietnamese militia that were charged with protecting the field failed to keep out the VC infiltrators. The VC removed roughly half the mines and used them for their own purposes throughout the province.[159]

110. Because the war did not develop any specific fronts, the VC did not lay protective minefields, but instead took mines to the Americans by targeting roads and footpaths. Instead of laying the usual type of minefield, the VC generally laid mines singly or in small numbers at strategic points with no established patterns of employment. From 1962, US

---

[155] Members of the Defence Research Board drew some interesting observations of Korea. See, for example, DHH 494.013 (D9), "CAORE, Notes on Operational Experiences in Korea", December 1950-June 1951.
[156] US, Department of the Army, *Land Mine Warfare*, Field Manual 20-32, (Washington, Army Headquarters, 1959).
[157] Mike Croll, p. 102.
[158] Mike Croll, p. 111.
[159] Mike Croll, p. 104.

Army studies indicated that the VC increased their use of land mines to produce casualties and initiate ambushes, and employed them with "imagination and foresight".[160]

111. VC mines were a constant threat to American forces. Although the US employed Claymore mines as an offensive weapon, most of its efforts were concentrated on defence. The VC were masters of the ambush and employed "nuisance mining," scattering mines throughout an area rather than in well-defined minefields on a scale never before encountered by US forces. Trained personnel who had detailed knowledge of the terrain usually installed mines at night. Through ingenious techniques in mine warfare, the VC successfully substituted mines for artillery. Instead of conventional minefields, the VC hindered off-the-road operations by planting explosive devices in indiscriminate patterns. While this caused combat casualties and delays in tactical operations, equally important was the psychological effect: "Just the knowledge that a mine or booby trap could be placed anywhere slowed combat operations"[161].

112. In response, the US Army concentrated their efforts in strategic planning, research and analysis, and material development for mine countermeasures. The Mine Warfare Center of the Headquarters, United States Army, Vietnam (USARV), conducted an extensive study of the VC and North Vietnamese mining operations, techniques and ordnance. The Mine Warfare Center found that although VC and North Vietnamese techniques varied from place to place, they did not use the traditional minefields of previous wars. Protective fields were laid around the more permanent base camps, but with no distinct pattern, and the mines were almost certain to be booby-trapped. The Center also discovered that the enemy tended to mine the same areas repeatedly.[162]

113. Most US mine casualties occurred during road clearing operations. Heavy losses coupled with the need to clear many kilometres of road put a strain on the combat effort. AP mines were set in unusual, often random patterns and locations, on a massive scale to trap the individual soldier. Virtually every enemy position was encircled or infested with them. The VC was able to adjust their mining pattern according to US tactical operations, rather than follow a preconceived plan. During periods when US activity was high, there was a substantial increase in VC mining efforts. Mining was largely the work of local forces, rather than the larger VC and North Vietnamese units.[163]

114. Because many types of mines were encountered in a diverse environment, the US Army took steps to educate all subordinate commands concerning mines, including techniques that might be used in countering them. In land clearing operations, plows were used to reduce the effects of mines and remove vegetation to eliminate cover.[164] Paving roads, training dogs and encouraging local citizens to report the location of mines in return for a cash reward proved to be effective means to counter enemy mines. Mine detectors designed to locate metallic mines or minute pieces of metal were not effective, since the VC sprinkled artillery fragments and metal on dirt roads. Infrared detectors were also largely unsuccessful.[165]

115. Countermine activities were oriented toward finding mines after they had been

---

[160] United States Military Assistance Command, Vietnam, "Lessons Learned Number 42: VC Employment of Land Mines", (San Francisco, October 1964), p. 4.
[161] Lieutenant-General John H. Hay, *Tactical and Material Innovations*, (Washington, Department of the Army, 1974), p. 131.
[162] John H. Hay, p. 131.
[163] John H. Hay, p. 132.
[164] Major-General Robert R. Ploger, *US Army Engineers, 1965-1970*, (Washington, Department of the Army, 1974), p. 100.
[165] John H. Hay, p. 134.

positioned and toward improving the ability of personnel to survive an explosion. In Vietnam, the US forces attacked the source of the problem. The Americans dealt with the mine problem by trying to prevent their enemies from laying them, by trying to detect implanted mines, and by deliberately detonating mines. With no set battle lines, it was felt that the effects of mines could be countered by attacking the enemy as they attempted to lay mines. Tactical operations including ambushing and patrolling were set up at likely enemy mining locations and were designed to disrupt the VC's mining efforts. The most useful technique to defeat random mining was frequent and aggressive ambush patrols in repeatedly mined areas designed to kill soldiers who were laying the mines or destroy the supply system that furnished the weapons. Since the use of AP mines was spread over wide areas, the amount of intelligence and the number of men that could be spared from other duties limited the use of ambush patrols.[166]

116. Once the problem areas were isolated, sensors were installed to detect movement in locations where there was repeated mining, artillery concentrations were plotted and night observation devices were positioned so that the unit could respond. These countermine efforts seemed to reduce the number of incidents, but the effects were difficult to measure and did not neutralise the effectiveness of the VC's mine warfare campaign. The mining problem in Vietnam was never solved to the extent that operations could be conducted without provision for detection. Considering the magnitude of effort that the VC put into mines and booby traps, the US was unable to find an answer to the problem of how to counter them. Although no single system of mine detection was markedly effective and losses occurred regularly in clearing operations, the overall effects of AP mines were reduced by a combination of old and new techniques.[167]

117. In the many cases when armoured fighting vehicles were used to transport troops in terrain with particularly dense foliage and infested with mines, infantry troops remained mounted to assault the objective, as the carriers detonated AP mines and booby traps.[168]

No. Detonated	230
No. Causing Casualties	206
KIA	16
WIA	394
Casualties/Detonation	1.8
No. of Multiple Incidents	106
Percent of Multiple Incident	46%
No. of Multiple Casualties	310
Average Casualties per Multiple Incident	2.9

Table 5: 9th US Infantry Division: Mine and Booby Trap Casualties, April 1969

118. As table 5 indicates, of all mines and booby traps detonated by the 9th US Infantry Division in April 1969, 46% resulted in multiple casualties. This was caused by the bunching up of troops as they walked closed up in single file, instead of spreading out as skirmishers. To prevent such incidents, mine and booby trap data was published in handouts that encouraged soldiers to avoid bunching up, avoid walking on trails and rice

[166] General Donn A. Starry, *Mounted Combat in Vietnam*, (Washington, Department of the Army, 1978), p. 81.
[167] John H. Hay, pp. 134-136.
[168] John H. Hay, p. 111.

paddy dikes, and to probe jungle foliage carefully.[169]

119. Through carefully concealed AP mines hidden in unlikely places and mines that blended in with the natural vegetation and surroundings, the VC created a fearful respect for these weapons amongst American combat units. In late spring and early summer of 1966, the 9th Marines was responsibly for clearing the rice paddy-and-hedgerow complex south of Da Nang: "The enemy they found hardest to combat was not the VC; it was mines"[170]. One company of the regiment, Delta, lost 10 killed in action and 58 wounded in action in five weeks: two men were hit by small arms fire, one by a grenade. Mines inflicted all other casualties. Only four of the wounded returned to duty. As patrol teams moved forward, they found mines everywhere: "There seemed to be no pattern to their emplacement. They had been scattered at trail junctions, at the intersection of rice dikes, along fences, under gates"[171]. Anywhere the movements of the Marines were anticipated, AP mines were buried.

Weapon	**WW II**		**Korea**		**Vietnam***	
	Deaths	*Wounds*	*Deaths*	*Wounds*	*Deaths*	*Wounds*
Fragments	53%	62%	59%	61%	36%	65%
Small Arms	32%	20%	33%	27%	51%	16%
Mines & Booby Traps	3%	4%	4%	4%	**11%**	**15%**
Punji Stakes						2%
Other	12%	14%	4%	8%	2%	2%

*January 1965-June 1970

Table 6: Distribution of US Casualties

Source: Vietnam War Almanac, Col Harry G. Summers, Jr., 1985

120. According to 1983 Veterans Administration figures, 47,244 Americans were killed in action in Vietnam. Particularly revealing was the cause of US battlefield casualties. As table 6 illustrates, in World War II and Korea, "fragments" (i.e. shrapnel from artillery, rockets and mortars) were the primary cause of US Army deaths and wounds. While they remained the primary cause of wounds in Vietnam, rapid-fire infantry weapons such as the AK-47 rifle changed the primary cause of deaths in Vietnam to small arms fire. However, total casualties from mortar and mine fragments (70%) totalled more than twice those caused by small arms (30%).[172] Casualty statistics from other reports supported these findings.[173] Although bullet wounds proved more lethal, the incidence of fragment wounds was far more numerous because the extremities were particularly vulnerable to landmines and booby traps.

---

[169] Lieutenant-General Julian J. Ewell and Major-General Ira A. Hunt, *Sharpening the Combat Edge: The Use of Analysis to Reinforce Military Judgement*, (Washington, Department of the Army, 1974), pp. 136-147.
[170] Captain Francis J. West, Jr., "Mines and Men," In *Small Unit Action in Vietnam*, (Washington, Historical Branch, US Marine Corps, 1967), p. 3.
[171] Francis J. West, p. 4
[172] Hernan A. Campana, *et. al.*, *Analysis of 210 US Army Deaths in Vietnam from July to September 1967*, (Edgewood Arsenal, Department of the Army, 1970.
[173] John J. Kovaric, *et. al.*, "Vietnam Casualty Statistics," *Archives of Surgery* 98, February 1969, pp. 150-153. Reprinted in the *American Medical Association*; and Major Ian Sunshine, *Injuries of the Extremities in 369 US Army and Marine Corps Casualties in Vietnam*, (Edgewood Arsenal, Department of the Army, 1970).

121. Although exaggerated claims have been made that guerrilla weapons such as mines, booby traps and *punji* stakes caused the majority of Vietnam war casualties, they only represented the causes of 11 percent of those killed and 17 percent of those wounded in action.[174] The majority of these casualties occurred on reconnaissance missions along trails, rice paddy dikes and in the jungle. Other sources maintain that mines were the cause of 7% of combat fatalities for the entire war among army troops.[175]

122. As the war wound down in Vietnam, the number of friendly casualties due to mines and booby traps became more pronounced. The majority of all casualties from mines and tripwire booby traps occurred on reconnaissance missions. Most AP mines and booby traps were located along trails, rice paddy dikes and in the jungle growth. When soldiers plodded through a rice paddy for several hours in hot, humid weather, they became fatigued and the ability to concentrate was low, making them an easy target for AP mines and booby traps. Interestingly, nearly all the booby traps and mines encountered were not covered by fire or observation. This did not mean that the VC were not in the vicinity, but indicated that they used AP mines as a measure to keep US troops away from defensive positions. The VC relied heavily on the use of booby traps to divert movement.

123. The US used offensive mine warfare tactics against the VC and North Vietnamese. To attack the enemy over a dispersed area, the US used aircraft to deliver fragmentation devices. Antipersonnel bomblets like the BLU series were air-dropped and fitted with delay action fuzes to remain hazardous for extended periods of time. Cluster bombs opened up the possibility of seeding landmines from the air, either in support of tactical operations or behind enemy lines. Once available, air-delivered AP mines were dropped in huge numbers, largely against unforeseen targets. The new cluster weapons had the potential to substantially increase antipersonnel battlefield lethality.[176]

124. By fitting the bombs with delay action fuses, an area would remain hazardous for extended periods of time. Air dropped mines could be deployed quickly, with little logistical support, and could be laid deep within enemy territory. Air dropped mines unquestionably caused casualties and disrupted VC movements, but their employment was equally as hazardous to friendly forces because many failed to explode (and were subsequently collected by the VC to be used against the Americans), their location could not be marked, and with no self-activating mechanism or easy clearance technique, they contaminated large areas. Although they were useful under the right circumstances, airdropped AP mines were not well suited to an obscure enemy such as the VC, whose movements were frequently unknown.[177]

125. The war in Vietnam provides a test case for the successful use of AP mines against a superior enemy who was on the offensive. AP mines and booby traps were a consistent problem for the US Army. Although the war was won due to a number of factors, AP mines slowed advancing troops, and, in combination with the dense jungle, made movement difficult. The VC took AP mines out of their traditional role, and used them as offensive weapons to attack and harass their opponent. As a result, the Americans took casualties and were forced to allocate manpower and resources to mitigate the threat that posed by mines. The use of AP mines and booby traps had an adverse effect on American

---

[174] Harry G. Summers, Jr., *Vietnam War Almanac*, (New York, Facts on File, 1985), pp. 111-113.
[175] James F. Dunnigan, *Dirty Little Secrets of the Vietnam War*, (New York, St. martin's Press, 1999).
[176] Eric Prokosch, p. 107.
[177] Mike Croll, pp. 107-108.

morale. In the end, stealth, dispersion, concealment and simplicity countered superior technology and manpower.[178]

THE ARAB-ISRAELI WARS

126. AP mines did not play a major part in the military activity in the Arab-Israeli Wars. These wars emphasised mobile operations along an extensive border that could never guarantee protection from breaching operations. The power of AT minefields to halt or delay mechanised forces was demonstrated in 1956, when a company of Israeli trucks was easily put out of action as the vehicles attempted to pass through an Egyptian minefield. In attacks on defended positions, Israeli momentum was degraded by AT mines. In 1967, Israeli offensives were delayed by the use of Egyptian AT mines.[179] Both sides attempted without complete success to drive through minefields, and resorted to hand breaching. Later in the war, the Egyptians were caught between the advancing Israeli forces and the original defensive minefields along the Suez Canal.

127. The Egyptians made use of mines during the Yom Kippur War of 1973, despite their offensive orientation. By supplementing natural obstacles with mines and ambushes, Egyptian commandos caused some disruption and delay to Israeli forces advancing to reinforce the position along the Suez Canal.[180] When the Syrians stormed Israeli positions in the Golan, plow and roller tanks preceded their armoured forces. To enable attacks through minefields, the Israelis employed flails, rollers and ploughs for rapid breaching.

128. In areas where the most intense combat took place, mines were neutralised by Arab artillery. Landmine warfare did not represent any significant improvement over past technology. Both sides followed doctrine similar to that employed by the US and Soviets in World War II. The Israelis felt that minefields placed along the 1967 cease-fire lines played a useful role in the defence of the Golan Heights in 1973, but ordinary barriers and anti-tank traps were more important. The Israelis laid minefields along the Suez Canal, with as many as 750,000 mines deployed. The ease with which defences were penetrated did not necessarily mean that using AP mines was futile. It was suggested that had the troops on the border had sufficient mines and anti-tank weapons, the surprise Arab attacks might have been slowed.[181]

129. Following the war, the Israelis expressed a continued interest in developing minefield technologies. The object was to acquire systems that would dispense mines quickly and provide crude marking systems that would allow friendly tanks and personnel to navigate through the fields. After the war, as Arab terrorists adopted a tactic of nuisance mining, the Israelis continued to improve their countermine capability.[182]

130. The Arab-Israeli Wars were studied by defence analysts as an example of the form of warfare that would occur in Europe between Warsaw Pact and NATO forces. In the event of hostilities in Western Europe, NATO forces planned to lay massive minefields across Germany. During the 1950s, a number of scatterable systems (delivered by ground launcher, air, and artillery) and mechanical mine-laying methods were introduced to

---

[178] Mike Croll, p. 108.
[179] C.E.E. Sloan, p. 6.
[180] Anthony H. Cordesman and Abraham R. Wagner, *Lessons of Modern War, Volume I: The Arab-Israeli Conflicts, 1973-1989*, (Boulder, Westview Press, 1990), pp. 69-71.
[181] Mike Croll, p. 109.
[182] C.E.E. Sloan, p. 7.

accelerate the process, maximise lethality and offer economy in defence. Yet, the rapid pace of mobile warfare limited the utility of AP mines.

THE WAR IN RHODESIA

131. As NATO forces concentrated their mine warfare efforts on countering attacks by massed armoured formations in a general war, the use of mines in other conflicts around the world developed in a different direction. Vietnam had demonstrated the problems caused by AP mines in guerrilla warfare. These lessons were repeated in nationalist struggles against colonialism in Mozambique and Angola. By the 1970s, Rhodesia struggled against nationalist guerrillas employing offensive mine tactics. Surrounded by hostile states, and facing an international trade embargo, the Rhodesians attempted to counter the vexing problem posed by the mine threat.[183]

132. The first mine attacks in Rhodesia occurred in 1972 and continued with increasing frequency until the end of the war. White Rhodesians were as vulnerable to mine attacks as the Americans had been in Vietnam. The vast expanse of African bush, cut by a few dirt roads, was ideal terrain for offensive mining operations. A single man armed with AT and AP mines could be as effective as an aircraft with a full payload. The Rhodesians had few armoured vehicles. With only unarmoured vehicles for transport, the effects of mines were lethal.[184]

133. The Rhodesians focused their efforts on protecting the occupants of vehicles from the effects of mine blasts. Although mine-protected vehicles limited the damaged caused by AT mines, the preferable solution was to locate the mines before they caused damage. Clearing roads with conventional tactics was slow, demanded more manpower than the Rhodesians could spare, and exposed them to AP mines. Modifications to vehicles that spread the weight sufficiently so that it would not detonate a mine proved effective, but the guerrillas developed counter methods. The US had discovered that aggressive patrols limited mine attacks, but the Rhodesians had limited manpower, which made this tactic difficult to sustain. It was decided to isolate guerrilla support from neighbouring countries by laying minefields along the border. By the end of the war, the border minefields were partially complete, but were of limited success. There was insufficient manpower to cover them effectively by observation and fire and guerrillas were repeatedly able to breach them.[185]

134. In Rhodesia, offensive mining by guerrilla forces was never completely countered. However, through mine-protected vehicles, security forces were able to project their power into the countryside. Although there were casualties, AP mines did not induce the same level of caution as the US had experienced in Vietnam.[186]

THE WAR IN AFGHANISTAN

135. In the war in Afghanistan, mines were an important weapon to both sides. Mujahideen estimates of the number of Mujahideen soldiers and civilians killed or maimed by mines reach 25,000-50,000. The Soviets laid over 30 million mines (some estimates run as high as 50 million), including many non-metallic mines that were extremely hard to

[183] Mike Croll, p. 115.
[184] Mike Croll, p. 115.
[185] Mike Croll, p. 117.
[186] Mike Croll, p. 117.

detect. The Soviets also made extensive use of booby traps that were air dropped or scattered outside plotted minefields.

136. The Soviets used air - and land - deployed mines to reduce movement between Pakistan and Afghanistan, and as perimeter defences to guard strategic points. In some cases, they were also used to secure garrisons and prevent desertion. A Mujahideen commander described the impact of mines: "Our great problem here is mines. There are mine fields all around the town, and it is very difficult for us to attack. If we cannot find a way to clear the mines, the [opposition] can stand up to us"[187]. The Soviets made heavy use of mines to interdict supply routes and the guerrilla trails that were used to support the Mujahideen in the field. This activity produced many casualties, but was relatively ineffective in reducing the flow of supplies. Although the mine warfare effort grew steadily more sophisticated with time, Soviet mines largely had a harassment effect and most casualties were civilian. The Soviets even dropped booby-trapped explosives that exploded if touched, including ones disguised as watches, coins, ink pens, matchbooks, clothing, compasses, toys and rocks.[188]

137. The Mujahideen had serious and continuing problems in dealing with Soviet mines. They were forced to expose themselves as they tried to clear paths using metal rakes. They drove animals into minefields, threw rocks, used professional mine hunters or simply walked into them, accepting the loss of soldiers. Of the more notable - if ineffective - methods of clearing mines was to shoot at them from a distance. Mortar devices that fired small rockets dragging explosive cord were effective in clearing paths through AP mines around Soviet strong points, but throughout the war the Mujahideen were without effective mine-detecting and mine-clearing devices.[189]

138. The Mujahideen also made extensive use of AP mines, many of which were retrieved from Soviet minefields or supplied from external sources. Additionally, the Mujahideen were reported to have used unexploded Soviet bombs, forcing the Soviets to use combat engineers to clear mines from the start of the conflict. As the conflict progressed, the Mujahideen mining effort grew increasingly sophisticated. When the Soviets took the Mujahideen fortress at Zhawar on the Pakistani border, they found 6,000 AT and 12,000 AP mines. By 1984, Soviet publications warned that enemy mines could not be detected, and were concerned about the lack of adequate field-deployable technology for detecting mines.[190]

139. Whereas the Soviet used millions of land mines in Afghanistan to protect communist installations and deny Mujahideen use of their lines of communication, the Mujahideen used their limited number of mines more selectively and probably more effectively. So-called "green zones" (an agricultural area of gardens and vineyards that is bisected by irrigation ditches) were a constant source of trouble in Afghanistan. Green zones provided concealment for guerrilla forces and were practically impassable for vehicles. The green zones in many parts of the country provided optimum sites for ambush. Here, AP mines, AT mines and command-detonated mines were easily

---

[187] Anthony H. Cordesman and Abraham R. Wagner, *Lessons of Modern War, Volume III: The Afghan and Falklands Conflicts*, (Boulder, Westview Press, 1990), p. 165.
[188] Anthony H. Cordesman and Abraham R. Wagner, Vol. III, 1990, p. 165.
[189] Anthony H. Cordesman and Abraham R. Wagner, Vol. III, 1990, p. 167.
[190] Anthony H. Cordesman and Abraham R. Wagner, Vol. III, 1990, p. 167.

concealed, while ambush parties and snipers preyed on dismounted scouts and sappers.[191]

140. Soviet mine deaths initially were high until countermeasures (e.g. reinforced vehicles) were developed to cut the losses. The Soviets also captured far more mines before the Mujahideen could deploy them than they found during mine-clearing activities. In the early part of the war, twice as many Soviet soldiers were wounded by bullets as by shrapnel, but by the end of the war, 2.5 times as many were wounded by shrapnel as by bullets. Moreover, the percentage of multiple and combination wounds increased about four times over the course of the war, while the percentage of serious and critical wounds increased two times. Landmines were a primary reason for the increase in serious and critical wounds. The number of soldiers wounded by land mines increased 25-30 percent over the course of the war.[192]

141. Assessing the effectiveness of AP mines on supply, defence and operations in Afghanistan is problematic, but they did produce casualties. Some lessons both sides learned were that concealment and camouflage were critical, big AT mines were easy to spot, detection was no substitute for active neutralisation and detonation, and the use of conventional mine detectors was ineffective. Soviet mining in Afghanistan did not prevent Mujahideen operations, but it caused substantial casualties and forced more careful Mujahideen planning and co-ordination.[193]

THE FALKLANDS WAR

142. Extensive use was made of mines and barriers during the Falkland Islands campaign. The Argentinians carried out extensive defensive preparations from the time they seized the Falklands until the arrival of the British, by mining a number of areas where they anticipated British landings. Although precise records were not kept, the Argentinians laid at least 4,000 AT mines and 11,000 AP mines and booby traps, according to one estimate.[194]

143. The Argentinians faced a difficult task in trying to effectively mine the approaches to their key defensive positions. They failed to provide fire support, aggressive patrolling and direct fire cover to prevent rapid lane clearing by British Engineers and the penetration of their minefields. According to notable observers, more "aggressive patrol and fire support action might have had a significant effect since the plastic mines could not be detected and had to be removed by hand"[195]. Argentine mine defences represented a mix of old and new technologies. The older metal mines did not represent a challenge to British mine detection, but the new plastic mines presented a formidable set of detection problems. A number of minefields had to be fenced off and left in position after the war.

144. The minefields were competently laid and recorded, but after the British landed and threatened the defences of Stanley, random mining took place. This proved to be a problem during the conflict, as the British troops encountered mines without warning. During actions in the mountains, attempts were made to breach routes through identified minefields to attack Argentinean positions. Near Mount Harriet, a poorly fenced, rapidly placed minefield was identified only after a Marine reconnaissance patrol suffered a

---

[191] Lester W. Grau, "Mine Warfare and Counterinsurgency: The Russian View", *Engineer* (March 1999), p. 5.
[192] Lester W. Grau, p. 2.
[193] Anthony H. Cordesman and Abraham R. Wagner, Vol. III, 1990, pp. 167-168.
[194] Anthony H. Cordesman and Abraham R. Wagner, Vol. III, 1990, p. 291.
[195] Anthony H. Cordesman and Abraham R. Wagner, Vol. III, 1990, p. 292.

casualty from an AP mine. A path through the minefield had to be cleared to resume the attack. Elsewhere, assault units sometimes did not know where Argentinean mines had been laid until they were actually fighting through them.[196]

145. The Afghan and Falklands conflicts showed how the use of land mines in limited armed conflicts had limited results. Mines and barriers did inflict casualties and slowed advances. Mines also proved difficult to remove. In some cases, non-metallic mines presented serious detection problems. However, minefields never proved impassable, and could normally be overcome by a determined force. AP mines represented one barrier, but provided only minor delays and harassment, especially when not covered by fire. They could not halt a major attack unless they were combined with more dominant forms of defence, and never succeeded in presenting a prolonged obstruction to infiltration and infantry assault. In general, other barriers and weapons systems proved more effective than mines.[197]

146. The lack of countermine technology, however, presented problems for military forces. The inability to detect more modern AP mines, inadequate marking of mined areas, the lack of minefield records and the scattering of mines without regard to mine laying drills or patterns were all factors that contributed to the massive post-war problem of identification, marking and clearance of minefields.[198]

IRAN-IRAQ WAR

147. Barriers and minefields were extensively used in the Iran-Iraq War. Since they were initially on the defensive, the Iranians were the first to make use of mines and barriers. They were especially proficient in using terrain to channel the Iraqis into low-lying areas, and forcing them to engage in massive engineering efforts. When Iran forced Iraq on the defensive, the Iraqis made use of heavily defended AT and AP barriers, mines and fortifications sustained by networks of roads.[199]

148. Iran's lack of technology for breaching minefields and barrier defences helped Iraq during the phase of Iran's offensives. While the Iranians were uninterested in technological solutions for defeating mines, and used troops in human wave attacks to clear breaches, the Iraqis were usually careful to scout out minefields before attacking. It is unclear if advanced technology would have been successful in stopping Iranian tactics. As the Chinese demonstrated in Korea, and the VC in Vietnam, the losses suffered in human wave attacks against prepared AP mine positions are minimised by the use of surprise and careful planning. Static minefields played an important role in the Iran-Iraq War, but they had only a limited delay effect. Each side's AP barrier defences were effectual to the extent that they were actively defended. They did not act as force multipliers or as substitutes for troops or active defences. Iran demonstrated on many occasions that it could rapidly infiltrate and penetrate strong defences - a problem the Soviets experienced in Afghanistan.[200]

THE GULF WAR

---

[196] C.E.E. Sloan, p. 8.
[197] Anthony H. Cordesman and Abraham R. Wagner, Vol. III, 1990, pp. 382-383.
[198] C.E.E. Sloan, p. 8.
[199] Anthony H. Cordesman and Abraham R. Wagner, *Lessons of Modern War, Volume II: The Iran-Iraq War* (Boulder, Westview Press, 1990, p. 449.
[200] Anthony H. Cordesman and Abraham R. Wagner, Vol. II, 1990, p. 450.

149. With no natural defences along the southern border of Kuwait, the Iraqis followed the example of armies in the North African desert in World War II and made wide use of land mines in their extensive fortified areas. The pause between the invasion of Kuwait and the beginning of Desert Storm acted to Iraq's advantage by allowing it to develop vast minefields. It was reported that Iraq had 10 million mines in its inventory at the start of the war, and that more than 500,000 AP and AT mines were laid in the Kuwait Theatre of Operations. The Iraqis purchased a wide variety of advanced AP mines from a large number of European countries, particularly from the Soviet Union and Italy.[201] The Iraqi plan reflected the successes of their defensive strategy during the war with Iran, and was designed to slow the attackers and channel them in prearranged killing zones that allowed armoured reserves to counter attack.

150. Given the extent of Iraqi field fortifications in the Kuwaiti Theatre, Coalition landmine countermeasures and obstacle breaching took on added importance. Planning for Desert Storm revealed that existing clearing capabilities had limited ability to breach modern minefields. The sophistication of modern conventional mines employed by Second and Third World armies made most mine detectors ineffective in locating them, and made traditional prodding methods very hazardous. On the whole, however, coalition minefield breaching was not conducted under hostile fire. If this had been the case, "the breaches would have been more difficult because of the numerous systems and methods in use"[202].

151. Prior to the ground phase of Operation Desert Storm, the lack of modern countermine and clearance equipment was apparent. The US Army and its allies responded with existing systems and developed new mechanical obstacle-reduction methods. The arrival of the armoured combat earth mover (ACE), the battalion countermine set, and the combat engineer vehicle (CEV) mine rake significantly improved the breaching capabilities of US forces. Though not intended as an assault-breaching vehicle, the ACE proved to be a success in breaching obstacles that were not covered by fire.[203] However, it did nothing to assist the breaching abilities of light units assigned to critical missions. The mine equipment used by US forces to breach barriers without fully securing a position or dismounting demonstrated the value of dedicated barrier crossing and obstacle reduction equipment, as well as the importance of combat mobility.[204]

152. A variety of improvised countermine devices were developed in direct response to the types of mines in the Iraqi inventory. The equipment the Coalition used to penetrate Iraqi minefields included mine detectors, half-tracks with flails, rocket-assisted explosive hoses, fuel-air explosives, and systems that shot line charges across minefields.[205] The devices developed for Desert Storm were based on similar items improvised during World War II, Korea and Vietnam.

153. The Coalition used many different approaches to mine clearing. To clear trip wire-activated mines, several methods of projecting a grapnel into a minefield were tried. Among the systems deployed by the US and other coalition forces were the antipersonnel obstacle breaching system (APOBS), an explosive device that blasts a continuous 0.6 x 45

---

[201] William Schneck, "Desert Storm: Countermine Improvisations", *Engineer*, Vol. 22, July 1992, p. 2.
[202] Vernon Lowrey, "Initial Engineer Observations by Engineers in the Gulf", *Engineer*, Vol. 21, October 1991, p. 44.
[203] Vernon Lowrey, p. 44.
[204] Anthony H. Cordesman and Abraham R. Wagner, *Lessons of Modern War, Volume IV: The Gulf War*, (Boulder, Westview Press, 1996), p. 742
[205] Anthony H. Cordesman and Abraham R. Wagner , Vol. IV, 1996, p. 739

metre footpath through a minefield to detonate pressure-fused AP mines and displace or expose blast-resistant AP mines.[206] Improvised MIMICs (magnetic-influence mine-clearing device) were mounted on armoured or wheeled vehicles.

154. The US Army depended heavily on mine rollers and plows when breaching suspected minefields. These were exceptionally effective. Other mechanical and explosive breaching methods proved faster, but were limited in numbers. Mechanical systems lacked the mobility to provide responsive support to manoeuvring forces, diminishing their value to the operation.[207] Mine clearing line charges (MICLIC) mounted on armoured vehicles proved more mobile, but did not alleviate all other operational problems.[208] These techniques were not useful for clearing all AP mines. Most of the mines in the Iraqi inventory had blast overpressure-protected fuses that were highly resistant to clearance by explosive line charges and fuel-air explosives.[209] Breaching by Air Force bombing was also ineffective. Bombing was met with only limited success because the bombs did not follow a straight path through enemy minefields, and made proofing with Plows and rollers difficult. They also left metal fragments that interfered with mine detection.

155. Although the Iraqis developed formidable and complex minefields to blunt penetrations into Kuwait by Coalition forces, these mines failed to slow, much less stop the Coalition's ground attack.[210] Several factors were of critical importance. The Coalition was able to survey the minefields with considerable success and exploit weaknesses in their layout and design. The air campaign did not destroy minefields, but it weakened Iraq's forward-deployed units, undermined morale and weakened their ability to defend and cover the mines with fire. The Iraqi forces also stayed in their defences and were reluctant to aggressively patrol and defend their barriers, especially at night. The Iraqis placed too much emphasis on artillery, and did not deploy an effective anti-armour capability in forward areas. They did not realise that the Coalition had equipment to penetrate minefields and barriers without extensive dismounting and delay. Coalition forces were thorough in training for breaching operations, had ample time to employ suitable equipment to enter the mined areas before the land campaign, and were able to maintain high momentum - largely as mounted forces - throughout the actual breaching operation. The Coalition had a decisive advantage in fire, air support, and mechanisation throughout the operation.[211]

156. Iraqi minefields were ineffective because they were neither aggressively defended nor were they linked to a realistic appraisal of Coalition capabilities. The Iraqis did not understand the Air-Land threat that it faced and was unable to defend its barriers.[212] For the coalition, although superior firepower and mobility prevailed, mines added to the strain of war, creating fear and adding extra resources and training requirements for successful operations. AP mines were peripheral to the outcome of the Gulf War. As the Israelis discovered during the Yom Kippur War, the Iraqis found out that barrier minefields were effective only to the extent that they were actively defended and used to enhance other

---

[206] Harry G. Summers, Jr., *Persian Gulf War Almanac*, (New York, Facts on File, 1995), p. 84.
[207] Vernon Lowrey, p. 44.
[208] Vernon Lowrey, p. 45.
[209] William Schneck, p. 7.
[210] Harry G. Summers, Jr. , 1995, p. 194.
[211] Anthony H. Cordesman and Abraham R. Wagner, Vol. IV, 1996, pp. 738-739.
[212] Anthony H. Cordesman and Abraham R. Wagner, Vol. IV, 1996, p. 739.

weapons.[213] If the Iraqis had worked harder on their minefields, and had directed more firepower to cover them, they may have exacted a higher toll, especially on the US Marines. The contrast between the sophistication of AP mines and counter-mine measures was striking. Lieutenant-Colonel Bruce Gombar observed: "We have all kinds of smart guys developing all kinds of smart weapons, but nobody really developed good mine-clearing techniques … Mine technology is way ahead of counter-mine technology"[214].

157. The US Army concluded that it had no way to counter scatterable mines if these had been encountered away from a deliberate breach site and that it needed a stand-off minefield detection system to rapidly detect minefields. These conclusions indicate that defended and scatterable minefields could be made significantly more effective in the future. Combat engineering capabilities of many units needed to be strengthened and mine protection equipment developed to counter scatterable and nuisance mines, and to provide suitable coverage for rapid breaching operations and self-extraction of vehicles. Such systems potentially include remote-controlled vehicles capable of emulating combat vehicles to cause premature detonation. As a result of the Iraqi experience, the US Army is examining options for an "intelligent minefield" that will provide digitised mapping and target tracking of mines, as well as smart AT mine systems.[215]

INTRA-STATE CONFLICTS AND THE CULTURE OF MINES

158. Since the Second World War, mines have played a prominent role on the battlefield. Although the effects of AP mines were never decisive, they complimented other weapons in limited wars and were probably more influential when used in a disruptive manner at strategic points, or to deny opponents access to an area, rather than as static barriers. Without creating a great logistical burden, AP mines could be laid rapidly to adapt to terrain, types of forces and the changing tactical situation. This expanded the mine's role from a defensive weapon to an offensive one. Technology driven armies such as the US could deliver mines behind enemy lines, while guerrilla forces could disrupt conventional armies through the cunning use of AP mines and booby traps.[216]

159. The traditional view of AP mine warfare as it emerged in the twentieth century has been Western-oriented. The utility of AP mines is usually viewed in terms of their ability to assist in economy of force, emphasise firepower and deny mobility during set-piece battles between organised units. However, this utility exists only as long as all warring factions share the same basic values. Indeed, the present Western evaluation of AP mine effectiveness has not considered the tenets of other military cultures, where the guiding principles of AP mine warfare were not shaped by conventional military behaviour. Inflicting casualties is one form of measuring Western military effectiveness, but to other cultures this is an alien concept. As the Soviets demonstrated during the Second World War, the ability of the attacking side to absorb punishment was a factor in determining national power and did not affect the legitimacy of the political leadership. Outside of the Western tradition, the use of AP mines has implied a greater domination over nature and epitomised the capture, control and possession of people and/or property. The key to AP mine effectiveness does not always lay in the ability of one side to inflict casualties and damage but in the ability to shape the terrain and influence operations.

---

[213] Mike Croll, p. 121.
[214] Michael R. Gordon and General Bernard E. Trainor, *The Generals' War: The Inside Story of the Conflict in the Gulf*, (New York, Little, Brown and Company, 1994), p. 360.
[215] Anthony H. Cordesman and Abraham R. Wagner, Vol. IV, 1996, pp. 741-743.
[216] Mike Croll, p. 123.

160. When dealing with the AP mine as a cultural weapon, effectiveness adopts an entirely different meaning. Other ethnic nationalities and tribes have used them to fulfil dissimilar objectives. For instance, the VC used and improved upon AP mine techniques. Unconventional, psychological and civic affairs operations in which AP mines were used often functioned alongside of military doctrine as rational precursors to effectiveness. While American planners in Vietnam thought in terms of conventional actions, the response by the VC in the South, including AP mine and booby trap activity against US personnel, developed along a different path based on a sense of retaliation and sabotage that complicated the nature and extent of US effectiveness.[217]

161. The relative importance of AP mines assumed a greater operational rationale where the strategic focus was not on the destruction of the opponent's army and the ability to continue to wage war. The new set of conditions and ranges of effectiveness with which AP mines have been increasingly employed in the post-1945 period underscored differing approaches to AP mines as another weapon for human conflict.

162. Very few wars since 1945 conformed to the traditional pattern of a clearly demarcated conflict between nation-states. Most conflicts took place in complex terrain such as mountains and jungles, and did not involve massed combat power or mobility. During the 1970s and 1980s, numerous intra-state conflicts and civil wars raged throughout the developing world. The typical scenario saw guerrilla groups opposing a Soviet-backed State government in a low technology, low-intensity, protracted war. Cambodia, Afghanistan, Mozambique, Angola, Ethiopia and Somalia entered into such conflicts. As eluded to previously, it is important to understand that modern intra-state conflicts in areas of the developing world promoted a different style of mine warfare from that of conventional war among Western states. AP mines were used in barrier minefields to prevent the steady flow of refugees into neighbouring countries

163. As Soviet military doctrine reacted to guerrilla warfare in the post-1945 period, their defensive philosophy was largely shaped by their experience of the German invasion in 1941. It was believed that mines played a significant role in halting the Germans and were henceforth considered to be indispensable for the defensive. Those Warsaw Pact countries that bordered the West along their frontiers used AP mines to prevent their citizens from fleeing to the West. By the mid-1970s, the Warsaw Pact forces had over fifty types of mines that were cheap to manufacture, easy to use and required limited training.[218]

164. In addition to the creation of barrier minefields, Soviet doctrine stressed the protection of perimeters of airfields, barracks, bridges and other potential targets with a belt of AP mines. This practice was exported to developing countries in the Third World. The Chinese also adopted the Soviet doctrine of mass AP mine laying. When exporting military technology, only part of the Soviet weapons arsenal was appropriate to the tactical situation and environment of the developing world, since neither the terrain nor the anticipated enemy threat lent themselves to sophisticated Soviet technologies designed to operations in Europe. Moreover, the developing world had insufficient infrastructure, technical expertise or organisation to sustain advanced technology systems imported from a superpower. Rather, combat in such situations was more suited to foot soldiers using

---

[217] Larry E. Cable, *Conflict of Myths: The Development of American Counterinsurgency Doctrine and the Vietnam War*, passim., (New York, New York University Press, 1986).
[218] Mike Croll, p. 125.

light weapons, grenade-launchers, mortars and AP mines.[219]

165. AP mine use was ideally suited for various cultures fighting terrorists and engaging in guerrilla warfare. Guerrilla warfare generally consists of raids by small groups of widely scattered, lightly armed irregular soldiers who live in remote areas and among sympathetic villagers. Guerrilla forces operated outside of the parameters of international law, and found that the efficacy of AP mines outweighed any treaty - especially if a guerrilla force was not a signatory.[220] Because of their limited resources, they must attack soft targets, often seeking out civilians and infrastructure to force governments to deploy large numbers of conventional soldiers, and act in an authoritarian manner to control population. Guerrillas have not only used AP mines as offensive weapons (as the VC in Vietnam), but also to protect guerrilla-held settlements and key areas from interference. In general, AP minefields were laid by hastily armed irregular soldiers and civilians, with little or no formal training or education in mine warfare. Consequently, few AP minefields were recorded and marked. Government forces rarely saw any advantage in marking AP minefields because "these were the very weapons on which they relied, not just to deter their enemies but to kill them"[221]. As conflicts progressed, more troops, civilians and irregulars laid AP mines, the location of which was increasingly difficult to discern.

166. Retaining the population in rural settlements became a key government objective. The depopulation of an entire countryside resulted in the loss of agricultural production, additional refugee burdens and the abandonment of land to guerrilla forces. Protective AP mines inhibited attacks and promoted caution among guerrillas. Few irregular armies had mine detectors. Surprise attacks could only be made following covert breaching operations and would certainly be hampered. To further deter attacks, government troops laid AP mines across likely approach routes to settlements in an attempt to kill guerrillas before they reached their objective. The protection of settlements tended to displace guerrilla activities to more vulnerable targets. As the British had discovered during the Boer War, placing mines along likely ambush points and using AP mines to protect railways was economical, and dramatically reduced the frequency of attack. Thus, protracted intra-state conflicts and civil war involving government forces and irregular guerrillas precipitated the widespread use of unmarked AP mines around settlements, infrastructure, jungle paths and other places. AP mines were deliberately laid in areas close to human habitation.[222]

167. Guerrilla forces used AP mines both offensively and defensively. If they lacked the means for an attack and the strength to hold a settlement, AP mines were sufficient to ensure that pathways were used infrequently. Footpaths leading from government-held areas were seeded with AP mines, making aggressive patrolling by government troops hazardous or even inhibiting it altogether, since they lacked the resources to clear roads and paths on a daily basis. In addition, approaches to guerrilla bases were mined to prevent penetration and to act as "silent sentries"[223].

168. Because pitched battles between guerrillas and government forces were sporadic, conflicts often centred on mines. Having originally been developed to enhance defensive positions, the AP mine became a primary weapon of war. Firefights in conflicts in the

[219] Mike Croll, p. 126.
[220] Lester W. Grau, p. 6.
[221] Mike Croll, p. 126.
[222] Mike Croll, p. 127.
[223] Mike Croll, p. 128.

developing world were not fought by tanks and guns, but by mines. Both sides "found themselves engaged in self destructive dependency"[224]. Given the nature of the conflict, mines served as an effective and realistic means of defence.

169. AP mines became a significant problem after conflicts because there was neither an effort to clear them nor was there any attempt to keep accurate records. Most mines were laid in close proximity to areas frequented by civilians. Victims of AP mines (returning refugees were especially prone) were often the people that the mines were supposed to protect. The failure of the government to clear AP mines at the end of a war was the result of several factors. Many conflicts did not really end, the security situation remained tense even after a cease-fire, and there was a reluctance to dismantle defences. With no outside assistance, governments in the Third World have little expertise or resources to clear AP mines. Many did not even realise that there was a problem until NGOs brought it to their attention, because people in the developing world are much more likely to die from other causes than AP mine accidents. There has been little incentive for Third World governments to divert their limited resources, ability or will to mine clearance.[225]

170. Because the deployment of AP mines was often indiscriminate and irresponsible, this has led to continuous post-conflict civilian casualties. The misuse of mines has resulted in a substantial shift of international opinion against their acceptability. While acknowledging their military utility, the international community considers the humanitarian cost so grave as to demand a complete ban on the use of the AP mine. Subsequent efforts have been launched to mitigate the effects of AP mines through clearance and providing medical assistance to casualties.

THE EVOLUTION OF AP MINES

171. The use of mines has been considered an unchivalrous, yet practical necessity. Traditionally, landmines were a means of transforming the terrain to the defender's advantage, rather than providing a definitive barrier. AP mines can inflict casualties, but to be effective they need to be covered by observation and fire. Although they do not define the outcome of battles, they can shape the attacker's posture, and provide economies in defence while imposing attrition on the attacker. AP mines are more easily laid than removed. They create fear, they do not recognise cease-fires and they do not discriminate. According to a recent history, landmines "are a trap set by the cunning and detonated by the imprudent"[226].

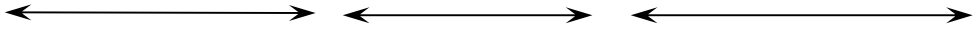
172. Early mines were expensive in time, manpower and consumed an inordinate amount of resources for marginal increases in combat power. Yet, time consuming, hand-emplaced obstacles were acceptable in earlier times because warfare was a hand-to-hand profession, the tools were relatively simple and the operational tempo allowed it. As the operational need for more effective weapon systems increased, new developments in mine technology were harnessed in an attempt to shape the battlefield and impact the war.

173. Although these weapons have changed from the concealed spikes of antiquity to electronic-fused weapon systems on the modern battlefield, and modern technical advances have allowed for a greater, more lethal impact on tactical operations, the principle has

[224] Mike Croll, p. 128.
[225] Mike Croll, p. 129.
[226] Mike Croll, p. x.

remained inviolate. In the end the evolution and development of AP mines came to reflect the aim of commanders, who used them to aid in the institutionalized process of imposing damage on enemy forces.

Operational Need: Low Medium High



Technology Advancement

Time Line / Device	Pre Civil War	American Civil War	WW I	WW II	Korea and Vietnam	Present Day
Area Weapons	NA					reliable production, Scattered and emplaced
Influence Activated	NA				Production, Hand emplaced. Scattered munitions under development	reliable production, Scattered and emplaced
Contact Activated	NA	Improvised blast devices, electronic initiation unreliable	adapted munitions, blast devices unreliable production	production blast, Trip Wire (TW), reliable production	Production blast, TW, Area Weapon Development, Scattered munitions under development	Production reliable, Scattered, and emplaced
Non Blast Devices	Stakes, Spikes and Traps	Stakes, Spikes and Traps	Stakes, Spikes and Traps	Stakes, Spikes and Traps	Stakes, Spikes and Traps	Stakes, Spikes and Traps

Table 7: The evolution of AP mine Technology to meet Operational Need

174. Today, there are many reliable means of production of AP mines, with options for scatterable and emplaced mines, contact, influence or trip wire initiation and both direct blast effects or fragmentation over an area. The US Army has concluded that defensive minefields and rapidly scatterable minefields could be made significantly more effective in the future.

CONCLUSION

175. What do the lessons of history tell us about AP mines? Although a complete template is not attempted here, history evinces several ways in which AP mines impacted land force operations. These include:

a. AP mines had numerous functions and roles, but their actual operational effectiveness was dependent on the nature of the terrain, the type of war, the arrangements of different weapons, the training and tactics of opposing forces and the combat circumstances under which they were employed.

b. Like other devices, AP mines evolved as a unique weapon of war with highly specialized applications. Because of their flexibility, low cost, and ease of use, AP mines were perceived to be operationally effective and were depended on to:

(1) act as force multipliers;

(2) serve as defensive barriers, exploiting concealment, depth and covering fire;

(3) economize on the defence while imposing casualties;

(4) cover withdrawals; and

(5) induce caution in the minds of soldiers in advancing armies.[227]

c. The number of casualties produced was not always a crucial element in determining the operational impact of AP mines on land operations.[228] The psychological effects induced by AP mines goes beyond the recording of numbers. In addition, the cascading effects of AP mines in terms of operations delayed, plans disarranged, extra time and resources imposed, and objectives unachieved are difficult to record statistically.

d. A systematic combination of other lethal weapons (i.e. tanks, air power, artillery, mortars, and machine guns) was equally, if not more, efficient and could be suitably used in place of AP mines. The use of manoeuvre or a superior concentration of force and firepower could overwhelm AP mines.

e. AP mines may not have been war-winning weapons and did not singly influence decisive battles. It was extremely rare that a tactical situation arose where AP mines alone were the single killing agent. The same could be said for any other weapon. AP mines did however render movement at the lower levels difficult (especially when used in combination with AT mines) and did influence the pace of operations.

f. In mid-to high intensity conflicts, where organized forces fought conventionally, AP mines found in barrier, static and protective obstacles proved relatively inconsequential if a sufficiently determined or concerted effort was made to overcome them.

g. Irrespective of other considerations, most armies used any means available - including AP mines - to enhance combat effectiveness while diluting enemy forces by causing attrition. Even if they were not always used effectively all the time, this fundamental requirement dictated that AP mines be physically and technically adapted to the environment and then deployed to meet combat conditions.

h. AP mines were also used effectively in an *offensive* capacity by different cultures in diverse conflict settings (low-intensity conflicts, and limited, insurgency or civil wars), often without pattern or discrimination. Typically, unconventional forces (e.g. paramilitary, irregulars or guerrillas) relied on AP mines to control or frighten local populations. Disruptions, delays and psychological effects were inflicted because most military operations had to be conducted dismounted. Western armies were reluctant

[227] These elemental roles are in Mike Croll, p. 22.
[228] In terms of the percentage and number of casualties, AP mines ranked considerably low, causing about 2%-6% of casualties.

to use, readily accept or appreciate AP mines in this capacity.

i. Marking and recording friendly AP minefields and detection and clearing enemy minefields were problematic. Coupled with their inflexibility once they were laid, these difficulties frequently mitigated against the operational effectiveness of AP mines and made them hazardous to soldiers when they were engaged in combat.

j. It was extremely difficult - if not impossible - to search and to guard large areas, continually and thoroughly, against AP mines that are used to hamper the movements of dismounted troops.

AREAS FOR FUTURE RESEARCH

176. As a first effort, this study has provided some evidence regarding the operational effects of AP mines from a historical perspective. While it is recognized that the efficacy of AP mines is complicated by a number of factors, the historical record demonstrates that AP mines served a military purpose in combat operations. If a replacement weapon is indeed necessary, it must be able to meet the roles that the AP mines provided. It appears that, as a result of the several functions provided by AP mines, further areas of investigation need to be pursued:

a. Can command detonated Claymores or pre-planned mortars provide barrier/ perimeter protection, deter hand breaching and inflict personnel casualties as effectively as AP mines?

b. Can other weapon systems produce comparable psychological effects such as the inability to fight back, uncertainty and fear, and instil the same level of caution as AP mines?

c. Can modern sensors provide continuous, all-weather surveillance and early warning of dead ground, perimeter fences and other obstacles?

d. Do scatterable mines offer the flexibility needed to restrict the mobility and reduce the operational tempo of detected enemy formations? Is there any alternative to scatterable AP mines that would allow breaches and gaps to be closed?

177. The next phase of this study will examine the impact of removing the AP mine on land force operations and determine if the current mix of weapons can compensate for their loss. The third phase of this study will identify the requirements and alternative concepts for replacement systems that meet the restrictions of the Ottawa Convention.

DOCUMENT CONTROL DATA
(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (the name and address of the organization preparing the document. Organizations for whom the document was prepared e.g. Establishment Sponsoring a contractor's report, or tasking agency, is entered in Section 8).

Operational Research
Department of National Defence
Ottawa, Canada, K1A 0K2

2. SECURITY CLASSIFICATION (overall security classification of the document, including special warning terms if applicable)

UNCLASSIFIED

3. TITLE (the complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title)

Historical Uses Of Antipersonnel Landmines: Impact On Land Force Operations (U)

4. AUTHORS (last name, first name, middle initial)

Roy, Roger L., Friesen, Shaye K.

5. DATE OF PUBLICATION (month Year of Publication of document)	6a. NO OF PAGES (total containing information. Include Annexes, Appendices, etc.)	6b. NO OF REFS (total cited in document)
October 1999	50	228

7. DESCRIPTIVE NOTES (the category of document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Research Note

8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include the address).

Directorate of Army Doctrine

9a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)	9b. CONTRACT NO. (if appropriate, the applicable number under which the document was written.)
N/A	N/A

10a. ORIGINATOR's document number (the official document number by which the document is identified by the originating activity. This number must be unique to this document.)	10b. OTHER DOCUMENT NOS. (Any other numbers which may be assigned this document either by the originator or by the sponsor.)
DLSC RN 9906	N/A

11. DOCUMENT AVAILABILITY (any limitations on further dissemination of the document, other than those imposed by security classification.)

(x) Unlimited distribution

( ) Distribution limited to defence departments and defence contractors: further distribution only as approved

( ) Distribution limited to defence departments and Canadian defence contractors; further distribution only as approved

( ) Distribution limited to government departments and agencies; further distribution only as approved

( ) Distribution limited to defence departments; further distribution only as approved

( ) Other (please specify):

12. DOCUMENT ANNOUNCEMENT (any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in 11) is possible, a wider announcement audience may be selected.)

13. ABSTRACT (a brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), or (U). It is not necessary to include here abstracts in both official languages unless the test is bilingual).

In December 1997, the *Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Antipersonnel Mines and Their Destruction* was signed in Ottawa by 126 nations. Militaries are understandably reluctant to suddenly give up a weapon system that has been part of their doctrine and procedures for decades. One of the dilemmas is to determine if AP mines provide a significant effect on the modern battlefield and to quantify the capabilities that the antipersonnel mines provided. The aim of this study is to determine the impact of removing antipersonnel landmines on land force operations and to determine if replacement technologies are necessary. As the first report in a three part series, this research note examines the historical uses of AP mines in order to identify capabilities they provided.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified . If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

- Antipersonnel Landmines
- Historical Uses
- Land Operations
- Operational Research
- Alternative Technologies

Canada