

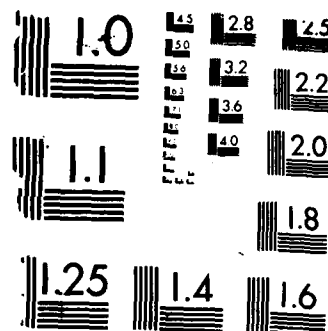
NO-A182 849

LAND MINE WARFARE - APPLYING THE PRINCIPLES(U) ARMY WAR 1/1
COLL CARLISLE BARRACKS PA M S ANDERSON 23 MAR 87

UNCLASSIFIED

F/G 15/6 6 NL

					END 8-87 DTIC							



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

AD-A182 849

STUDENT ESSAY

The views expressed in this paper are those of the author and do not necessarily reflect the views of the Department of Defense or any of its agencies. This document may not be released for open publication until it has been cleared by the appropriate military service or government agency.

DTIC
ELECTE
AUG 03 1987
S D
C&D

LAND MINE WARFARE--APPLYING THE PRINCIPLES

BY

COLONEL MARTIN S. ANDERSON

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

23 MARCH 1987



US ARMY WAR COLLEGE, CARLISLE BARRACKS, PENNSYLVANIA

DISCLAIMER NOTICE

**THIS DOCUMENT IS BEST QUALITY
PRACTICABLE. THE COPY FURNISHED
TO DTIC CONTAINED A SIGNIFICANT
NUMBER OF PAGES WHICH DO NOT
REPRODUCE LEGIBLY.**

USAWC MILITARY STUDIES PROGRAM PAPER

The views expressed in this paper are those of the author and do not necessarily reflect the views of the Department of Defense or any of its agencies. This document may not be released for open publication until it has been cleared by the appropriate military service or government agency.

LAND MINE WARFARE- APPLYING THE PRINCIPLES

An Individual Essay

by

Colonel Martin S. Anderson

Colonel William G. Kosco, EN
Project Adviser

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited

US Army War College
Carlisle Barracks, Pennsylvania 17013
23 March 1987



Accession For	
NTIS CRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
111	Avail and/or Special
A-1	35

ABSTRACT

Author: Martin S. Anderson COL, EN

Title: Land Mine Warfare- Applying the Principles

Format: Individual Essay

Date: 23 March 1987

Pages: 40

Classification: Unclassified

A historical analysis of land mine warfare repeatedly demonstrates certain principles which when correctly applied yield decisive results. This essay begins by examining the employment of mines in four battles- Alam Halfa, El Alamein, the Golan, and the Falklands. It then assess how well our current land mine warfare doctrine, organization, and equipment facilitate the timely and sound application of the fundamentals demonstrated by history to today's AirLand Battlefield. Areas in which we must improve or change are identified, and some new ideas are proposed.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Land Mine Warfare - Applying the Principles		5. TYPE OF REPORT & PERIOD COVERED Individual Essay
7. AUTHOR(s) Colonel Martin S. Anderson		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army War College Carlisle Barracks, PA 17013		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS Same		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE 23 March 1987
		13. NUMBER OF PAGES 42
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public releases; distribution is unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A historical analysis of land mine warfare repeatedly demonstrated certain principles which when correctly applied yield decisive results. This essay begins by examining the employment of mines in four battles - Alam Halfa, El Alamein, the Golan and the Falklands. It then assess how well our current land mine warfare doctrine, organization and equipment facilitate the timely and sound application of the fundamentals demonstrated by history to today's Airland Battlefield. Areas in which we must improve or change are identified and some new ideas are proposed.		

It can be said that the only constant in today's technologically equipped Army is change. This assertion certainly seems applicable when the capabilities that technology has given a new generation of land mines are compared to those of their World War II antecedents. Yet, the fundamentals governing employment of land mines have remained unchanged over time. Simply stated they are: put mines where the enemy can and will come; place them in depth and to achieve surprise; cover them with observed and integrated fires; and, in recognition of their non-discrimination between friend or foe, always record their locations. History gives us many examples of the extent of delay, disruption, and destruction caused by mines in battle situations where these principles were applied correctly. By first examining some of these historical battles we can better understand how to apply the principles on today's AirLand Battlefield.

Battle of Alam Halfa¹

In the North Africa theater during World War II, as would be the case in most other theaters, the value of mines was recognized early and their use grew as the campaigns progressed. From their role in strong point defense at the Omar Forts and in the perimeter at Tobruk their employment steadily expanded. For the battles that were to take place in the El Alamein area minefields extended to form a continuous barrier from the shores of the Mediterranean to the impassable Qattara Depression, a distance of some 40 miles. In June, 1942 Rommel's German and Italian Panzer Armee had reached the Alamein area exhausted and spent in pursuit of the British after their victory over them at the Gazala line.

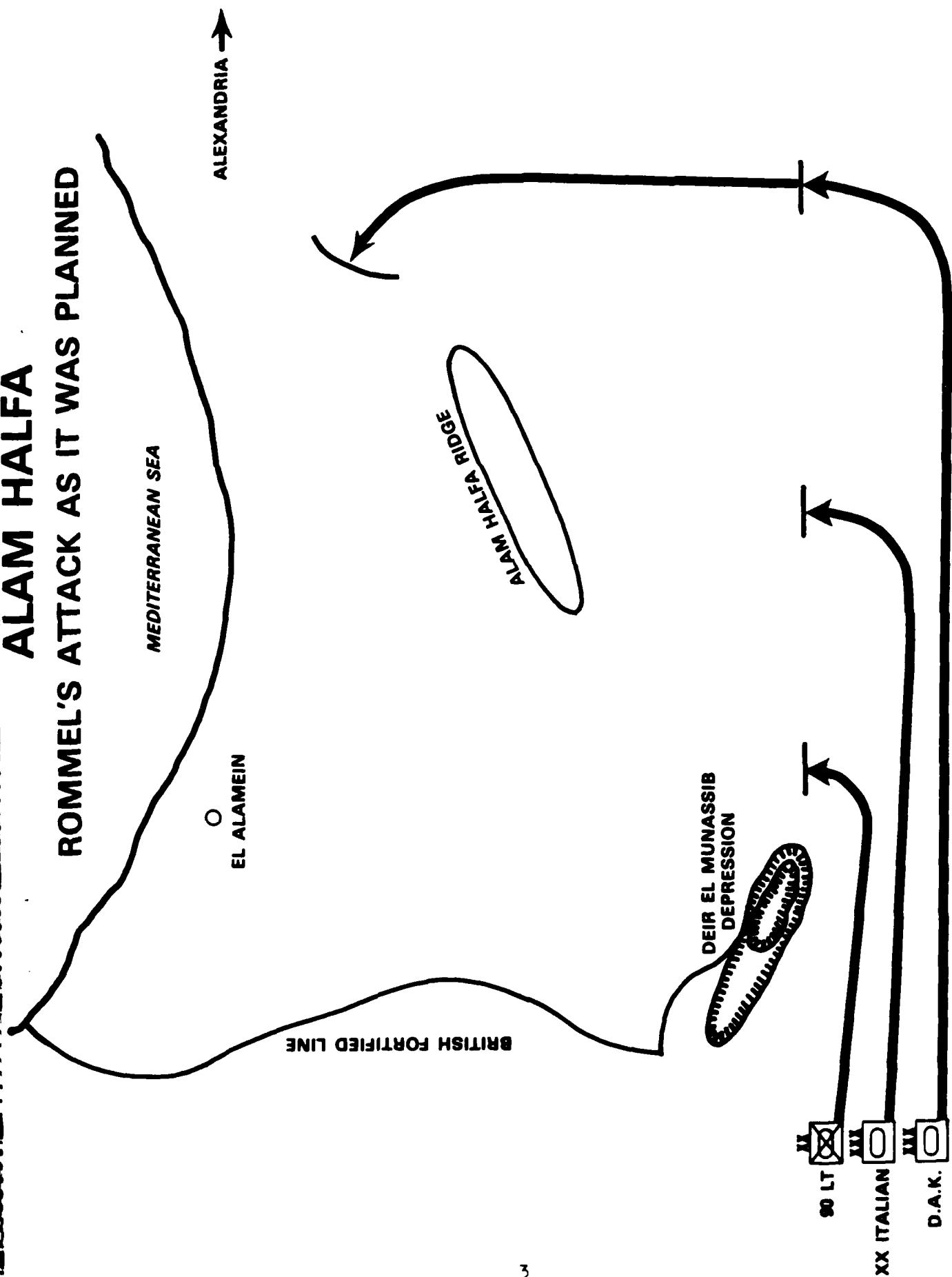
During July and August as both armies paused to refit Rommel made his plan for what he knew was a last chance offensive to reach Alexandria and

the Suez. Logistics, the eventual deciding factor in war, favored the British. It was only a matter of time before their strength would become overwhelming. The Alamein line which had turned into a static front during this break in action presented the one terrain situation in North Africa where there was no open flank in which the Afrika Corps (D.A.K.) could conduct the sweeping envelopments for which it was renowned. Rommel concluded that his forces would have to conduct a quick penetration of the front. His reconnaissance had repeatedly indicated that the southern most sector, a 15 mile stretch between the Munassib Depression and Mount Qaret el Himeimat adjoining the Qatarra Depression was only lightly mined and defended. While he could not achieve surprise in direction he hoped to gain surprise another way-- in time and speed.² He would carefully conceal assembly of his forces in the sector, break through in a night attack, and be some 30 miles into the Eighth Army rear by dawn. He would count on the usual slow reaction from the British leadership. With light forces securing the opened corridor, he would then advance north with his armor to the coast and British supply areas thereby drawing out their armor and defeating them in open maneuver. (Sketch 1)

Rommel was mistaken, however. Montgomery, the new Eighth Army commander, had discerned his intentions and was ready with his armor positioned in the rear on the key terrain feature, the Alam Halfa ridge, which Rommel had hoped to have flanked by dawn. Worse still, in the sector to be penetrated there were two extensive antitank mine fields, code named January and February. These fields were each some 300 meters wide and were separated from each other by 2000 to 6000 meters.³ The 7th armored Division (composed of light tank, armored car units, and lorried infantry) had been positioned to give mobile cover to these fields. Clearly the British had

ALAM HALFA

ROMMEL'S ATTACK AS IT WAS PLANNED



© MT. EL HIMEIMAT
QATTARA DEPRESSION

SKETCH 1

applied the fundamentals correctly: Mines in depth had been placed undetected astride the attack routes of the Panzer Armee and forces had been positioned to cover them so that a methodical attack with successive breaches would be required rather than a hasty breach the Germans were anticipating.

The attack kicked off as the moon rose just prior to midnight on 30 August 1942. German pioneers and infantry led their tanks. Rommel's own words tell the story: "Shortly after passing the eastern boundary of our own minefields our troops came up against an extremely strong and hitherto unsuspected British minebelt, which was stubbornly defended. Under intensely heavy artillery fire, the sappers and infantry eventually succeeded in clearing lanes through the British barrier, although at the cost of very heavy casualties and a great deal of time--in many cases it needed three attempts. The minefields which contained an extraordinary number of mines (according to our estimate there were 150,000 in the sector where we attacked), were of great depth and protected by numerous boobytraps."⁴ It wasn't until 0430 that the first field was cleared so by dawn the leading elements were only eight miles from their line of departure instead of the 30 miles envisioned. Clearly the required elements of speed and surprise had been lost. Rommel, who had gone up front to assess the situation, considered calling it off. But hearing that his Afrika Corps' 15th and 21st Panzer Divisions had finally cleared the mines in their sector and were ready to begin their eastward march he approved a shortened enveloping attack. It was a fateful decision because it brought the Afrika Corps against the prepared armor positions at Alam Halfa (Sketch 2). The battle raged for another day before Rommel, his forces under constant RAF air attack and almost out of fuel, was finally forced to call off the offensive. A gradual

ALAM HALFA

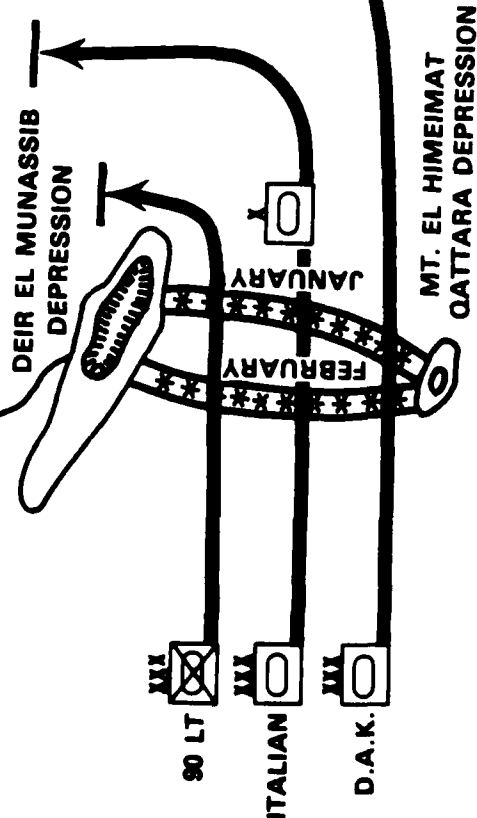
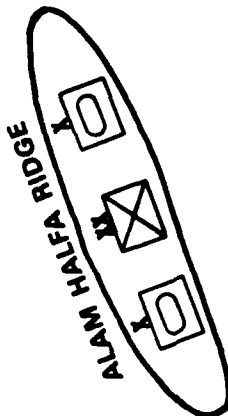
ROMMEL'S ATTACK AS IT WAS EXECUTED

MEDITERRANEAN SEA

EL ALAMEIN

ALEXANDRIA →

BRITISH FORTIFIED LINE



withdrawal took place from 2-4 September surprisingly with out counterattack from Montgomery who apparently feared that his armor would be lured into one of Rommel's traps if he pursued.

No less an authority than B. H. Liddell Hart has called Alam Halfa a turning point in the North Africa theater, even more than Alamein that was to follow, because the strength of each side was roughly equal and victory was still a possibility for Rommel. While it can be argued that airpower was a decisive element in this battle, it is equally true that Rommel's operational plan which was bold enough in its conception to provide for a triumph was wrecked in its execution upon two defended minefields named January and February.⁵ If there was any consolation prize for Rommel it was that he now held these two fields.

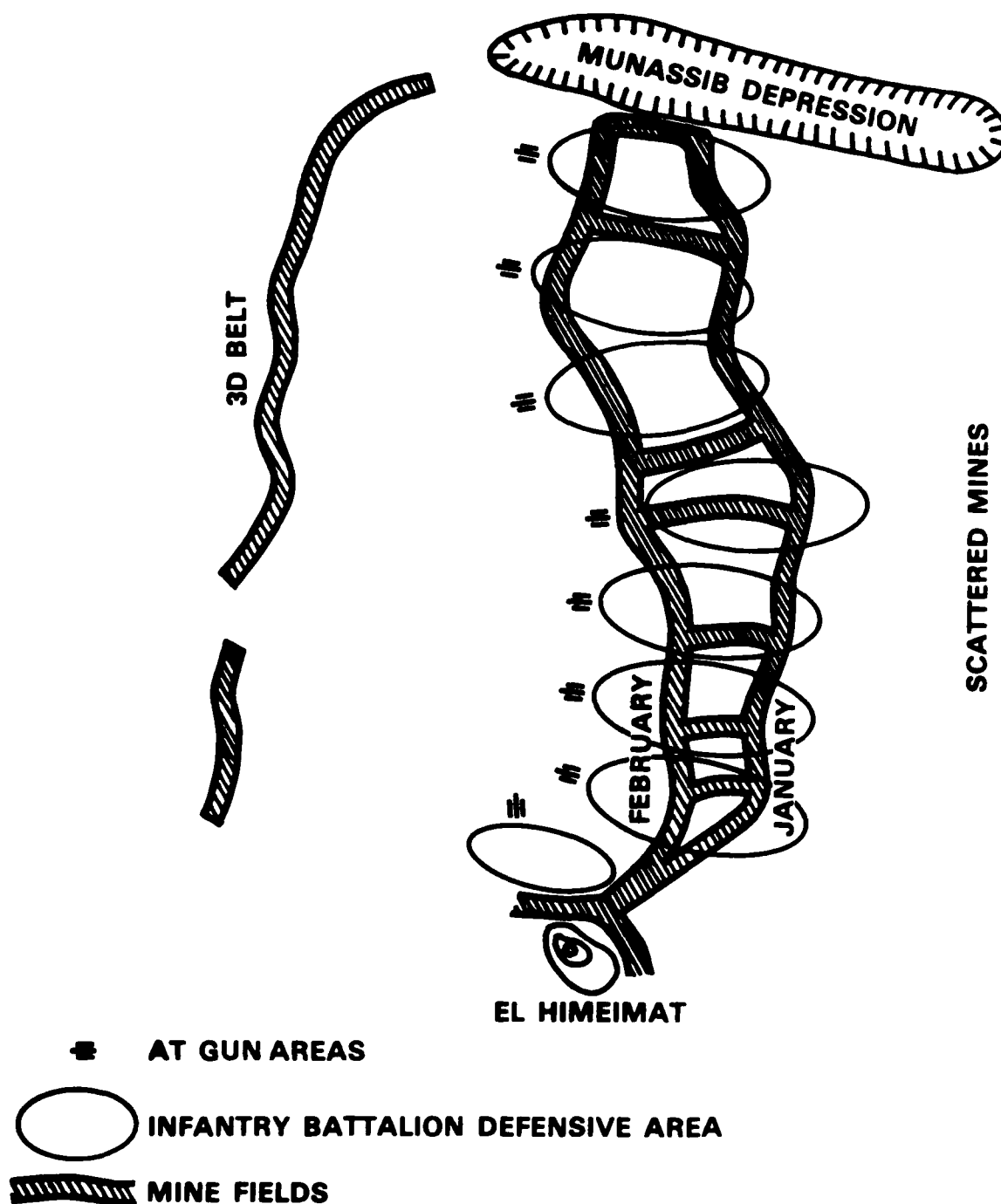
Battle of El Alamein⁶

With the tables turned, it was now Rommel's task to devise a defensive scheme for capitalizing on the nature of the Alamein line -- secure flanks that required an attacking enemy to force a breakthrough. Rommel concluded that a fortified Alamein line, if it could be held long enough by infantry, would enable a mobile reserve of armor to be employed to defeat breakthroughs. In order for the infantry to hold, mines in depth would play a vital role along with the covering fire of machine guns and antitank guns. It would create a great economy of force advantage against an attacking British force that was to have over a two to one advantage in every category- men, artillery, tanks, and air power. Rommel gave his personal attention to the creation of this defense and in particular to the type of minefields to be emplaced. Called Devil's Gardens, these minefields had been under construction since July with the effort intensifying after Alam

Halfa. By 23 October 1942, the eve of Alamein, they stretched the whole 40 mile length of the front and were in depths up to 8 miles.

A military intelligence report details their construction and reveals how the fundamental principles were applied.⁷ As in the case of the captured January and February fields the mines along the length of the line were generally layed in two main frontal belts each usually a few hundred meters wide and separated from each other by three to seven thousand meters (Sketch 3). At intervals of about 5,000 meters transverse belts were laid connecting these main belts. The resulting hollow squares acted as traps for troops and tanks which succeeded in penetrating forward defenses thereby robbing them of maneuver space and permitting enfilade fire from the rear belt and dividing walls, as well as providing for artillery concentrations. Within these squares numerous booby trapped mines and wire obstacles were laid to coincide with the fields of fire of concealed guns. In front of the forward belt random grouping of mines were layed apparently to disguise the locations and patterns of the boxes. Battalions were assigned frontage of about 1 1/2 kilometers to defend. In each battalion sector the outer belt was held by mutually supporting battle out posts dispersed in depth by one of the battalion's companies which could withdraw through narrow lanes as they delayed the attack. The remainder of the battalion was in position behind the second belt extended to a depth of two kilometers where the larger antitank guns were positioned. A third defensive belt, eight miles from the forward positions and beyond the reach of a single night's penetration, was also constructed. Indeed, Rommel conceived a formidable defense reflecting the full application of sound mining principles. If there was any weakness it was an insufficient number of anti-personnel mines

GERMAN DEFENSES AT ALAMEIN — SOUTHERN SECTION



SKETCH 3

Plans called for a third of all mines to be antipersonnel, but, in fact, only about 4 percent of the mines laid were of this type.

Montgomery's plan of attack was straight forward and capitalized on the British ability to carry out a resolute frontal attack. It called for a main attack in the north by XXX Corps and a secondary attack in the south by XIII Corps. He envisioned a break-in by the infantry and engineers who under continued artillery coverage would widen the breaches. The German and Italian holding troops would then be methodically destroyed in a process he called crumbling. Faced with this situation the enemy's armor would have to be committed, and in turn would be destroyed by positioned British armor. Careful preparations were made, and, in particular, the problem of breaching minefields at night was given extensive training time to rehearse the procedures that would be used.

In every attacking division sector along the length of the Alamein line there are spectacular accounts of the first phase of battle, known as the Dogfight, that lasted from 23 to 26 October. Each deserves telling, but for brevity and continuity the role of the January and February mine sector will be discussed. The XIII Corp's plan called for its 7th Armored Division to make a night breach of four lanes through the January and February fields (a distance of some 6,000m) and establish an armored force in the resulting bridgehead by dawn. The supporting 44th division would provide flank protection and execute a single breach north of the 7th Armored Division. Available to the 7th Division were specially organized engineer breaching teams containing Scorpions, tanks with flails mounted on their front. The attack got off to a bad start when scattered mines in front of the first mine belt caused the Scorpions to begin flail operations some 900 meters before the forward edge of January and subjected the clearing force to continuous

long range fires. Additionally, the battle outposts were stubbornly held and required determined infantry attack to reduce them. The cumulative effect was that by morning the lead brigade of the 7th Armored Division had breached only the January field and on only two lanes not the four planned at the cost of over 200 casualties. The Germans and Italians now made ready for the assault they knew would come on the February field that night and layed additional mines on the further side of February unknown to the British at the time. With the two remaining Scorpion's gaps were made that night but the tanks following at first light missed the openings and hit mines. Those that got through were hit by accurate antitank fire or ran up on the scattered mines that had been placed beyond February. With heavy tank losses a withdrawal behind February was once more made necessary. Because of the costly losses in this sector, Montgomery halted XIII Corps' attacks on 25 October and pulled out the 7th Armored Division for commitment in the north for the breakout phase which lasted from 27 October to 4 November. It took the remaining forces of XIII Corps another five days to finally breach the January and February fields and the third field eight miles beyond.

If Alam Halfa was the turning point in North Africa then Alamein completed the turn. Unable to position his reserves to achieve concentration, Rommel was forced to piecemeal his counterattacks and Montgomery had the superiority of numbers to make the crumbling process work. But it remains that mines accomplished what Rommel had expected under the circumstances. He remarked, "as it was, the British suffered considerable losses in our minefields and we managed to shoot off at them almost all the ammunition we had stored in the Alamein line."⁸The Alamein battle

demonstrates the offensive corollary to mine obstacles that any barrier can be breached, but only if enough time, effort, and lives are expended.

The Battle of the Golan⁹

The defensive battle fought by the Israelis on the Golan Heights in the 1973 Yom Kippur War offers an excellent latter day case study of how correctly employed mines with other obstacles can enable an outnumbered defender to succeed. The Golan battle is especially significant because it involved Soviet equipped surrogate forces attacking more or less according to Soviet doctrine. The purely defensive phase of this critical battle lasted some 36 hours from 6 to 7 October 1973 and involved 5000 Israeli infantry supported by 44 artillery pieces and 177 tanks from two armored brigades defending against a Syrian force whose attacking first echelon of three mechanized divisions alone had 45,000 men in 1400 armored personnel carriers and 600 tanks with 700 artillery pieces forward. The following second echelon had an additional 1000 tanks organized into two armored divisions. Attacking along two major axis each of which split into two prongs the Syrians were able to achieve force ratios of as much as 12 to 1 at some points of effort. The Israelis, however, had the advantage of terrain and they had scrutinized it closely taking every advantage it offered, especially in the norther sector which they considered the most dangerous approach. A thousand meters in front of their fortified armored platoon positions a tank ditch had been constructed whose effectiveness was enhanced significantly by integrated minefields laid in front of and behind the ditch.¹⁰ This arrangement caused the Syrians to have to lead with tank rollers and bring up armored launched bridges all of which were easy targets. Their tanks piled up on the obstacles. With losses of over half their armor in both

echelons the Syrian attack was repulsed in the north and ground to a halt in the south. The skilled and courageous defenders had succeeded, even if barely so, by the synergistic effect of correctly employed obstacles covered by accurate fire from carefully constructed multiple fighting positions.

Falklands¹¹

The 1983 campaign for the Falklands illustrates an example of how mines can fail to achieve results when the fundamentals are misapplied. According to available Argentine documents 40,000 antipersonnel mines and 5,000 anti tank mines were shipped to the Falklands of which half this number were emplaced by the approximate 800 man engineer force deployed. Most of the effort went into constructing minefields that covered amphibious landing sites to Port Stanley. The British, however, achieved surprise by making an arduous overland approach after landing at San Carlos. When it was realized that the attack to seize Port Stanley would come from inland the Argentines hastily laid mines on these approaches but the fields emplaced were poorly sited, lacked depth, and were not always covered by effective fires. In this light infantry war there was no attempt to integrate the mines with barbed wire to form complex obstacles which would have required deliberate attacks to breach them. The British simply went around the fields, or in some cases mounted attacks straight through them with relatively few casualties.

The AirLand Battlefield

Today's threat doctrine which stresses speed and high operating tempo forces us to apply the principles of mine warfare under the severe constraint of time as well as our always limited resources. Where the Germans, British,

and Israelis in the examples examined had months to prepare their defenses. we have at most a few days and perhaps just hours. If we are to realize the decisive contribution mine obstacles can make in winning the AirLand battle our doctrine, organization, and equipment must facilitate the application of the fundamentals demonstrated by history in the deep, security, defensive, and reserve operations that form the defensive framework of the AirLand Battlefield.

Deep Operations

The fundamental of depth as it applies to mines has an entirely different perspective on today's AirLand defensive battlefield. Where mines at Alamein extended from the main line of resistance rearward some 20 kilometers it is possible today to project out from the Forward Edge of the Battle Area (FEBA) hundreds of kilometers with air delivered mines as part of an air interdiction effort. This depth of mine emplacement that allows delay and disruption of second echelon forces at distances that translate into possibly days before their commitment to close-in battle transcends tactical application and takes on operational consequences. The current definition of mine warfare needs to be changed to recognize this enhanced mine capability for the land component commander.¹²

While the role mines can play in attacking the second echelon and supporting logistics are recognized, the provisions for their employment in the joint operational concept publication TRADOC Pamphlet 525-43 glosses over an important doctrinal issue- air delivered mines can be either oriented against targets or on terrain. Not surprisingly, because the air delivered mine is viewed as a munition, the emphasis in the employment procedures is on a target oriented mode.¹³

Target employment of mines, that is putting them on the top of enemy formations or installations, does offer certain advantages. A single F16 fighter carrying a normal load of six GATOR dispensers can put 432 antitank mines and 132 antipersonnel mines on an area 200m wide by 650m deep.¹⁴ This dispersion of lethal influence activated mines on a column would potentially attack many more vehicles than other air delivered munitions could. It presents to the enemy not a standard breaching problem, but an enormously more hazardous exiting problem.¹⁵ The effect then is immediate destruction, however, there are significant drawbacks in adopting the target approach. As pointed out by an Air Force author who has argued persuasively on this subject, moving targets must first be located by reconnaissance, then subsequently acquired by the aircraft crews sent out to deliver the ordnance.¹⁶ This is no easy or certain task even when the Joint Surveillance and Target Acquisition Radar System, JSTARS, comes along. Further, the formidable air defenses that accompanies threat formations make the attack of any column a hazardous business and requires that suppressive efforts have first been successful.

A terrain oriented approach, however, avoids or mitigates these problems to a large degree. Certainly the force package the air component commander must put together to employ mines in this mode would be much less than would be required in the target oriented approach and thus sparing of limited air assets. Employment of mines in the traditional terrain oriented method does not necessarily mean lessened effectiveness however. We just need to make certain the principles are applied correctly. Placing them on the routes the enemy can and will come is a function of careful terrain and intelligence analysis which should be reflected in the land component commander's barrier and obstacle plan whatever the level- corps, army, or

theater. To provide for observation remote sensors need to be emplaced and monitored. While the principle of covering by fire requires the Air Force to apportion a certain percentage of the available sorties to be able to rapidly react when sensors indicate significant activity, a column stacked up against such obstacles should facilitate target acquisition as well as enhance the effectiveness of the other munitions that would be brought to bear on these targets. However, even if coverage is not completely adequate the anti disturbance capability built into air delivered mines will ensure that an important degree of delay is achieved.¹⁷

In summary, we need to relook how we intend to employ air delivered scatterable mines in attacking second echelon forces to ensure we get the maximum effect for the minimum cost that they can provide. If they are to be available when we need them then we have to demonstrate how they will make the difference. To this end, an engineer needs to be included in the staffing of the Battle Control Element (BCE) that represents the land component commander at the Tactical Air Control Center (TACC).¹⁸ This will help ensure that the land component commander's barrier and obstacle plan is understood and its execution facilitated by the Air Force.

Security Operations

Linking the deep attack of second echelon forces to the close-in battle with first echelon forces are the operations conducted in the security area by a covering force established either by a corps or its divisions. Its vital mission is to "strip away enemy reconnaissance units, defeat the tank heavy advance guard, force the enemy to deploy his main body, and cause the enemy to bring up artillery and second echelon forces to organize a

deliberate attack."¹⁹ By any measure that is a tough job for the 4 or 5 battalions that may make up a covering force.

The element the covering force has to contend with is the threat advance guard which may be as much as a reinforced regiment for a division making a main attack. Normally it is 20 to 30 kilometers in front of the main body of regiments. Preceding the advance guard by 3 to 5 kilometers is a forward security element in battalion strength which in turn is preceded by combat reconnaissance patrols. In the forward security element there will be an engineer movement support detachment formed out of the division engineer battalion and specifically configured and equipped to quickly and effectively breach obstacles identified by the reconnaissance elements.²⁰ Its countermine equipment capability includes wheeled mine sweepers, engineer counterobstacle vehicles, and explosives. But this isn't all. In Soviet doctrine hasty breaching is an armor function and mineplows and minerollers are allocated on a basis of one per tank platoon and one per tank company respectively to enable them to accomplish this task.²¹ As many as 72 mineplows and minerollers are available to the mechanized rifle division and a 120 to the tank division. An additional critical function of obstacles employed in the covering force area then must be to attrit as much of this breaching capability as possible before it reaches and is employed in the main battle area. The engineer requirement in the covering force area then is to get the highest density of obstacles emplaced where they can have they greatest effect under the severest constraints of time and limited resources than anywhere else on the battlefield.

There are several conclusions that can be drawn about mine employment in this phase of the defensive battle. Reliance will be on scatterable mines since manpower or equipment intensive obstacles are impracticable due to

the time constraints and the distances involved in the covering force area. Rather than large linear fields, many smaller fields along avenues of approach will be more effective in accomplishing delay and attrition. Night mining will be necessary to achieve surprise and avoid detection by reconnaissance elements. Covering these fields with observation and fires will have to be done by remote sensors and attack helicopters.

Siting will be absolutely crucial and the full knowledge obtained from the Intelligence Preparation of the Battlefield (IPB) process and other intelligence indicators must be available to the maneuver commander and his engineer.²² There must be a responsive command and control of engineer resources. Under present engineer organization it is imperative to form an engineer task force whose commander would be of field grade rank and who would have a small staff element available to him to be able to accomplish planning and direct the effort required.

Whatever maneuver plan is decided upon for the covering force (it may range from attack to delay on successive positions) it will certainly place a heavy demand on the Family of Scatterable Mine Systems, FASCAM. Yet, FASCAMs whether artillery, air, or ground delivered are not a panacea; they are subject to real constraints in their employment.

The covering force battle may well occur beyond the range of most artillery other than that located with the covering force and the competing mission demands on this artillery will restrict its availability to employ scatterable mines. The multiple launch rocket system, MLRS, might be able to support the covering force from the main battle area (a mine round for this system is presently under development by the Federal Republic of Germany), but its primary mission has been stated as counterbattery and suppression of enemy air defenses, both full time missions.²³

Air Force delivered scatterable mines (GATOR) will also be limited due to requirements elsewhere in the air interdiction campaign, as well as heavy demands for other munitions in the close air support missions provided the covering force. What mining sorties are available may be better utilized in trying to interdict the following main body in order to buy time and even the odds for the covering force. Helicopter delivered scatterable mines can only be accomplished where the survivability of the helicopter is reasonably assured, a condition not likely to be met in the covering force area.²⁴ In this respect flank security mining missions would seem to be a better employment of this asset.

That leaves the ground FASCAM systems, GEMSS or its replacement, Volcano to meet the requirements. Unfortunately, the basis of issue of one per combat engineer company is woefully inadequate to the task at hand.²⁵ A tough decision must be made on consolidating available GEMSS or Volcano systems to provide the covering force engineers with the wherewithal to accomplish their mission even though this will affect the main battle area preparations underway and subject these limited ground FASCAM assets to combat loss.

Main Battle Defensive Operations

The main battle area by its definition will require the greatest obstacle effort. As our operational concept for land mine warfare correctly states, the primary reliance for the mining effort in this area will be on ground emplacement with mechanical systems and hand emplaced means.²⁶ Such are the competing demands on artillery for counterbattery, suppression of enemy air defenses as well as regular calls for fire that artillery delivered scatterable mines will be used mainly for targets of opportunity, reseeding

minefield breeches, and closing gaps and lanes. The problem is that there just aren't enough mechanical ground emplacement systems to go around and do the job everywhere it needs to be done. However, there is one resource that is available and that can finish the job- the manpower of the combined arms team. The challenge is to find better ways to organize, plan, and execute our conventional hand emplaced mining capability.

The US Army Engineer School has proposed a far reaching engineer organizational change to better provide combat engineer support to the heavy divisions in our force structure. It's called E-Force.²⁷ Essentially it restructures the present engineer support composed of divisional and corps assets so that each maneuver echelon in the division has an engineer element available of the commensurate level to support the maneuver commander. Under E Force an engineer battalion supports each maneuver brigade, and an engineer company would support each battalion sized task force. What this means to the mine emplacement effort is not that the number of engineer soldiers has increased, although they will be better organized and equipped, but that adequate engineer command and control is provided to plan and supervise the mining effort.

In a critical review of our present obstacle planning procedures at corps and division levels, two engineer officers have proposed a top down integrating approach in which corps and divisions specify obstacle zones and obstacle free zones rather than attempting to manage a multitude of individual obstacles as is done presently.²⁸ The effect of this aggregating of multiple obstacles into zones would be better support of maneuver plans and better focus of available engineer effort on major avenues of approach. Brigades and battalions would add the appropriate detail by devising the

obstacle belts to be constructed within these zones. This process would not only save engineer time but also facilitate prioritization.

As much merit as this proposal has, the fact remains that the siting of minefields which would comprise the aforementioned belts must be done on the ground where a keen appreciation for the terrain can be gained. The most critical planning event to ensure that the principles are applied correctly is the commanders initial reconnaissance. The engineer must be there with the maneuver commander when this reconnaissance takes place. It is then that the commander's concept of how he wants to defend and the engineer's advice on how obstacles can best support that concept can be properly integrated.

What needs to be available to the commander and his engineer during this planning process are some more definitive criteria to guide them in correctly applying the mine warfare principles. Ideally, they should be valid in any terrain setting or tactical situation. The criteria at figure 1 is an attempt to indicate what some of these criteria should be. They are not all inclusive nor can they guarantee the best solution. They are offered as a departure point to which the experience gained at the National Training Center (or anywhere else realistic training is conducted) can add.

Emplacing mines is recognized as a combined arms task. Present doctrine has the engineer responsible for laying the large tactical minefields using either mechanical scattering means or manpower to hand emplace them.²⁹ The latter method prescribes a standard pattern that yields an effective field in terms of its structural characteristics- density, number of lines of mines, and the interval between rows, but is terribly time consuming.³⁰ The infantry is responsible for being able to lay mines for close-in perimeter protection. The prescribed hasty protective minefield method for doing this

Minefield Siting and Emplacement Criteria

1. First determine how and where to stop the enemy and maneuver against him; then, site minefields.
2. Obstacles are most effective close-in where they can be placed under massed, observed, flanking fires of both anti-tank and automatic weapons.
3. For those fields that must be placed beyond direct observation and automatic weapons fire the engineer must coordinate with the intelligence officer for tasking of the military intelligence battalion to emplace and monitor remote sensors, and with the fire support officer for preplanned artillery fires.
4. The depth achieved should force the enemy to successively deploy and breach at least twice. This means generally that there should be at least three belts of minefields separated from each other by 300 to 500 yards. Each minefield belt should be at least 100 meters deep and achieve a density of one mine per meter of length or .004 mines per meter squared for anti-tank minefields.
5. The aggregate effect of all fields or belts emplaced should be to confuse the enemy's direction of attack. To this end, point minefields in front of and between tactical fields may be useful.
6. If possible minefields should be masked from direct enemy observation.
7. Minefields should consist of mines of varying type and fuzing if time permits.
8. As a minimum anti-personnel mines need to be provided in the most forward belt of anti-tank minefields and in the final protective belt.

Figure 1

is suitable only for emplacing the few number of mines available to these units in their basic loads.³¹ What is needed is a simple, standard method that can be used by both engineers and the combat arms to lay anti-tank mines either on the surface or, if time permits, buried.³² Such a method was used by the German army in World War II. A variant of it was incorporated in our 1943 field manual on land mine warfare.

Essentially the German method enabled a platoon to carry and rapidly lay 200 mines in a four row offset pattern that created a panel approximately 300 meters by 20 meters.³³ The length and depth of this panel could be easily varied. The panels were grouped to provide the overall length and depth desired in a sector. The American variant created a standard panel of 144 feet square which could also be extended in depth and served as a building block for creating larger tactical minefields.³⁴ The fundamental difference between the two methods were in how the functions of carrying, laying, burying, and arming were performed. We separated these functions and assigned them to squad teams to accomplish while the Germans did not.

Both methods, but in particular the German method, had characteristics we need in today's mining operations. Their simplicity makes them easy to learn, and, as a consequence, more manpower can be brought to bear on laying minefields in depth. They provide for easier control during emplacement and thereby facilitate night mining operations which may be the norm on the AirLand Battlefield. Finally, they are quick to lay. A German panel could be emplaced at night in 45 minutes which beats our day time planning rate for mine laying.³⁵

Reserve Operations

In concluding an examination of mine operations in the main battle area it is necessary to address the problem of maneuver for the counterattacking force whose job it will be to destroy and eject any enemy forces who have been able to penetrate the depth of the defense. There are two factors that must be planned

The first is to ensure that friendly mines do not restrict or impede the routes the counterattacking force will need to take. Careful provisions for these routes must be made in the obstacle planning process. It may be here that phony minefields, if properly constructed, can be of value to deceive the enemy. Additionally, careful recording and marking of all fields in the main battle area is a necessity and must be enforced. History offers many examples where grievous casualties were sustained by units on their own fields.

The other factor that needs to be incorporated into plans is the requirement to conduct hasty breaching operations. This could result from the need to change and adopt routes that would traverse friendly fields, or the more likely case, enemy mining operations by mobile obstacle detachments to protect the flanks of penetrations in accordance with threat doctrine.³⁶ In this respect, engineer reconnaissance teams must be formed and positioned to observe and report such mining quickly to counterattacking units. The engineer force designated for the reserve must be reconfigured from mine laying and be ready to conduct breaching operations. Finally, consideration needs to be given to consolidating available tank mine plows and mine rollers within the counterattacking force

The timely supply of mines in the quantities needed, at the locations they are needed, and at the times they are needed presents as much a problem today as it did in World War II. At Alamein the Germans were forced to improvise to compensate for their lack of adequate logistics. Artillery shells, aerial bombs, and virtually any explosive ordnance was adapted into their Devil's Gardens. They were also fortunate in being able to incorporate British minefields into their defensive plans. On today's battlefield we can't afford to rely on ad hoc measures. We need to address and solve now some of our more severe logistic constraints to modern mining operations.

Much is made of the reduced weight per meter of minefield when touting the advantages of scatterable mines yet this disguises some real logistic show stoppers.

Artillery delivered scatterable mines are first constrained by their allocation in the basic load prescribed for 155mm artillery battalions. The ten percent allocation which amounts to some 24 antitank RAAMS rounds per tube would enable a battalion to emplace only two preplanned 400 meter by 400 meter minefields in the desired density of .004 mines per meter squared.³⁷ Secondly, resupply rates for all artillery munitions are limited by the controlled resupply rate (CSR) which is usually less than the planned required resupply rate (RSR). Whatever is available has to be transported forward and scatterable mine rounds compete with the other needed artillery munitions for available transportation assets. While a solution is to anticipate requirements and preposition stocks at anticipated battery locations this presents a coordination nightmare not to mention an operations security concern.

Helicopter delivered scatterable mines raise many logistical questions. Will engineers or aviation personnel be responsible for rearming the air

Volcano system when it is fielded? Will rearming take place at the forward arming and refueling points (FARPs)? If so whose trucks will get the mines from the ammunition supply points (ASPs) or ammunition transfer points (ATPs) to the FARPs. As FM 1-104 points out the requirements for attack helicopter munitions alone will require every aviation vehicle employed in support of FARP operations.³⁸

Ground FASCAM systems will use a prodigious amount of mines by volume that will almost certainly require dedicated vehicles to resupply mines to the many locations where they will be emplaced. We need to determine how many vehicles can be committed to this requirement and from whose assets. We also need to determine whether these mines can be sent forward to and handled at the ATP's in the brigade support areas in order to reduce the travel times and distances associated with ASPs located in division rear areas.

Our present conventional mines weigh too much yet they will be needed so ways must be found to get them up front in quantity. The basic load of these mines for combat units must be increased from the present inadequate amounts.³⁹ A relook at load plans is needed to see if more carrying space and weight are available and ways to carry mines externally on vehicles should be investigated.⁴⁰ A study of the packaging of barrier materials has pointed out that 30 percent of mine packaged weight is in packaging material.⁴¹ Ways to combat pack mines to eliminate this weight must be devised and accomplished in rear areas by host nation support if possible.

The above are all issues that need answering in specific detail and incorporation into our doctrinal literature. We need to replace the present vague generalities that tend to wish away the logistic difficulties of mine warfare with thoughtout procedures that will work.

Better Training To Teach The Fundamentals

An Israeli officer, Brigadier General Avigdor Kahalani has made the observation "... Good obstacles and the correct use of terrain are the same thing as having extra tanks in your unit. Good execution of the basics comes from good training."⁴² Here is a voice we should heed for General (then Lieutenant Colonel) Kahalani commanded a tank battalion defending the Golan Heights in the 1973 war. Yet, as late as 1976, a TRADOC survey indicated that over half of U.S. infantry units never used mines on field training exercises.⁴³

Hopefully we have come a long way since then, but the question remains how well do we train in mine warfare? Hasty protective mining is a supplemental mission in infantry ARTEPS.⁴⁴ As one of nineteen such supplemental missions it may not even be selected for formal evaluation in a level one infantry ARTEP. By consensus, ineffective countermobility operations are cited as one of eight major recurring weaknesses observed at the National Training Center.⁴⁵ But even more than a lack of emphasis in training programs, the lack of a realistic training mine in sufficient quantities to test doctrine, explore new ideas, and exercise the logistic system lends weight to the criticism that "we are teaching all the wrong lessons" of mine warfare to a new generation of soldiers and leaders.⁴⁶ There should be no higher priority than getting conventional and scatterable mine simulators in the hands of our units in sufficient quantities to conduct real training. The results would convince even the most skeptical commander of the value of mines and the need for making mines a priority in training.

There are other areas of training that should also receive renewed examination. The question can be raised as to how well we train our

engineer lieutenants in terrain reinforcement. Progress has been made in computer simulations and there is now available at the US Army Engineer School a much improved simulation model, the Obstacle Planning Simulation (OPS), that challenges a student to devise an obstacle plan on a computerized map under time constraint.⁴⁷ A simulated battle using one of five attack options is then fought to calculate survive/ kill statistics between friendly and enemy forces. But the fact remains that computer simulations aren't enough. Real proficiency in obstacle siting will only come through training tied to actual terrain not computer simulated terrain. In our units there needs be initiatives to hold regularly scheduled obstacle siting tactical exercises without troops (TEWTS) with engineers and their supported maneuver counterparts. Good training in the basics of mine warfare is combined arms training not just engineer training.

Finally, there is the value of studying case histories. There is much to learn even in perusing some of our old doctrinal literature that incorporates the lessons of World War II and which has been lost in the revisions of these manuals. One example is particularly illustrative. In a discussion on mine field marking, the 1955 edition of FM 20-32, Land Mine Warfare, outlines fascinating reasons for marking the front of defensive minefields, a provision not even mentioned as a possibility in current how to fight doctrine.⁴⁸ In another vintage manual detailed planning considerations are outlined for the difficult task of a passage of lines through minefields, something a withdrawing covering force would have to be prepared to do.⁴⁹

Future technical developments

Besides keying our training on the fundamentals, our research, development, and procurement of mines with enhanced capabilities should

be similarly guided. In an era of once again declining defense budgets we need a rationale that the principles provide to be able to convincingly argue the merits of why we need scarce dollars for mine improvements.

To enhance surprise we need mines with multiple fusing options incorporating seismic and acoustical activated fuses to complement our singular reliance on magnetic fusing in all our current scatterable mines. We need, as a matter of priority, a new light weight conventional mine that will allow us to fully utilize our manpower to achieve mining in depth rather than rely on scarce mechanical systems. Additionally, FASCAM mines should be made adaptable to manual arming and emplacing. Finally, we need to solve the problem of recording mines to provide for safety and freedom of maneuver by exploring possibilities for on/off switching of minefields or a means of identifying activated mines thru non cooperative secure signatures.

Conclusion

This essay has attempted to explore ways to make land mine warfare a more effective contributor in the quantifiable calculus of today's AirLand Battlefield. But as Clausewitz reminds us, there are other intangible dimensions to battle. Effective employment of mines throughout the AirLand battlefield will not only make a significant contribution to the physical destruction of the enemy, but also will figure into his psychological disintegration as well. As a German prisoner of war remarked to his Russian captors in a sector of the eastern front in World War II where mines had been extensively employed, "...Mines are a terrible weapon...hundreds of soldiers were killed who had so far escaped death... We could not advance without first clearing away mines."⁵⁰ In the next conflict we need to be certain that it is our enemy who conveys this fear - not us.

ENDNOTES

1. Several sources were used in writing this account of Alam Halfa. Liddell Hart, Fritz Bayerlein, and G. P. B. Roberts, A Battle Report: Alam Halfa (Quantico Virginia: Marine Corps Association, 1956), 1-32 was especially valuable in its analysis of planning assumptions and relating viewpoints of key participants in the battle. BG (Ret) Vincent J. Esposito, ed., The West Point Atlas of American Wars vol II (New York: Praeger, 1959) 77, and, Michael Carver, El Alamein (London: MacMillan and Company, 1962), 41-74 provided operational and tactical detail.
2. Hart, et al, 29.
3. Colonel J. M. Lambert, "Engineers at the Battle of Alamein," Royal Engineer's Journal vol LXVIII, (March 1954): 20-29.
4. Liddell Hart, ed., The Rommel Papers (New York: Harcourt, Brace, and Company, 1953) 276-281.
5. Hart, et al, 4.
6. In compiling this summary of the battle of Alamein four sources were researched: Carver, 99-173; C. E. Lucas Phillips, Alamein (London: Heinemann, 1962) 70-220; I. S. O. Playfair, A History of World War II, The Mediterranean and Middle East vol IV (London: Her Majesty's Stationery Office, 1966) 1-80, and, Lambert, 20-29.
7. U.S. War Department, Military Intelligence Service Tactical and Technical Trends, no 32 (Washington: 26 August 1943), 33-34.
8. Hart, 332.
9. Source material for the Golan was obtained from the Insight Team of the London Sunday Times, Yom Kippur War (New York: Doubleday, 1974) 155-183; and, Nadav Safran, "Trial by Ordeal: The Yom Kippur War, October 1973," International Security (Fall 1977): 133-150.
10. LTC William G. Kosco, "The 1973 Middle East War- An Engineer's View," Military Engineer, vol 71 (November/December 1979), 395.
11. Primary source materials examined on the Falklands were Col J. M. Hill, "Sappers in the Falklands," Military Engineer, no 493 (May/June 1984).

162-166; and, Ejercito Argentino, Conflicto Malvinas Tomo I, II (Buenos Aires: 7 July 1983): seccion IV and Anexo 70.

12. Department of Defense, JCS Publication 1: Dictionary of Military and Associated Terms (Washington: 1 January 1986): 229 defines mine warfare as "The strategic and tactical use of mines and their countermeasures." While tactical use applies to both land and sea mine warfare it seems clear that strategic application refers to sea mine warfare only.

13. U.S. Training and Doctrine Command, Pamphlet 525-43, Joint Operational Concept for Coordination of Employment of Air Delivered Mines (Fort Monroe, VA: 26 September 1984): 9 states that even when the Army specifies desired target effects (i.e., delay) the Air Force will perform its normal target analysis and ordnance selection process to determine if mines are appropriate.

14. U.S. Army Engineer Center and School, Handbook of Employment Concepts for Mine Warfare Systems (Fort Belvoir, VA: August 1986): 50.

15. Dr. N. Gass, "Exiting Mined Areas," Ubique, no. 31, n.d.: 7-9 contains an analysis of the effects of emplacing scatterable mines at a simulated density of .002 mines/meter squared on a brigade command post and makes some recommendations on exiting drills.

16. Lt Col Price J. Bingham, "NATO Needs a New Air Interdiction Approach," Armed Forces Journal, October 1986: 100.

17. Bingham, 110.

18. U.S. Training and Doctrine Command, Pamphlet 525-45, General Operating procedures for Joint Attack of the Second Echelon (Fort Monroe, VA: 31 December 1984): 3-4 contains the Battlefield Control Element (ECE) manning TOE. Officer specialties included are 14, 15, 35, and 54.

19. U.S. Department of the Army, Field Manual 71-100, Armored and Mechanized Division Operations (Washington: 29 September 1979): 5-13.

20. U.S. Department of the Army, Field Manual 100-2-1: Soviet Army Operations and Tactics (Washington: 16 July 1984): 14-1 to 14-2.

21. FM 100-2-1, 14-3.

22. Among the more important products of the IPB process that would be invaluable to minefield siting are the weather and terrain overlays with event analysis templates to indicate the mobility corridors where threat forces are most likely to come. U.S. Department of the Army, Field Manual 34-3: Intelligence Analysis (Washington: January 1986): Chapter 4.

23. U.S. Army War College, Reference Text: Forces/ Capabilities Handbook, vol II (Carlisle Barracks, PA: 1987): 1-19.

24. U.S. Department of the Army, Training Circular 20-32-2: Employment of the M56 Helicopter Delivered Mine System (Fort Belvoir, VA: 30 September 1976): 4.

25. U.S. Department of the Army, Field Manual 20-32: Mine Countermine Operations (Washington: 9 December 1985): 81.

26. U.S. Army Training and Doctrine Command, Pamphlet 525-19: U.S. Army Operational Concept for Land Mine Warfare (Fort Monroe, VA: 18 June 1982): 3.

27. MG Richard S. Kern, "E-Force," Engineer, vol 16, Spring 1986: 10-15.

28. Major David A. Fastabend, and Major Ralph H. Graves, "Manuever, Synchronization, and Obstacle Operations," Military Review, February 1986: 36-48.

29. FM 20-32, 46.

30. FM 20-32, Appendix B contains standard pattern minefield computational data.

31. U.S. Department of the Army, Training Circular 20-32-1: Hasty Protective Mining (Washington: 15 August 1975): 1-20.

32. U.S. Army Material Systems Analysis Activity, Results of Armored Platoon Effectiveness Test, Phase I (Aberdeen, MD: September 1986): 2-46. Designed to quantify the contributions of minefields to the AirLand Battle this test came up with some interesting results, one of which was that M15 mines with tilt rods were more effective, i.e., resulted in more hits to tanks, when layed on the surface unburied.

33. Major M. L. Crosthwait, "Demolitions and Minelaying- Some German Methods," Military Review, October 1952: 76-82.

34. U.S. Department of the Army, Field Manual 5-3, Obstacle Technique (Washington: 30 June 1943): 31-36

35. Crosthwait, 81.

36. Major Arthur J. Parr, "Soviet Combat Engineer Support," U.S. Army Institute for Advanced Russian and East European Studies (Garmisch, Germany: 1 April 1978): 33-35 contains an excellent detailed discussion on the employment concepts and capabilities of the mobile obstacle detachment

37. U.S. Department of the Army, Training Circular 6-20-5: Field Artillery Delivered Scatterable Mines (Washington: 8 January 1982): 30 and Appendix C. Calculations were based upon the procedures discussed in this training circular for a transfer delivery technique employing high angle fire. Two aim points were required regardless of the Battery to Minefield Angle (BMA).

38. U.S. Department of the Army, Field Manual 101-4: Forward Arming and refueling Points (Washington: 31 July 1985): 13-14.

39. U.S. Department of the Army, Field Manual 101-10-1: Staff Officers: Organizational, Technical, and Logistic Data (Washington: 1 July 1976): 3-61 allocates one M21 anti-tank mine per 10 individuals in category 1 infantry divisions and two mines per 5 individuals in category 1 mechanized infantry divisions. This translates into only 80 mines for an infantry battalion and 350 for a mechanized infantry battalion.

40. Major Douglas H. Starr, "This Land is Mined Land Or Should Be," Armor, May/June 1977: 48.

41. U.S. Army Combat Developments Command, "A Study of Packaging of Field Fortification and Barrier Materials for Multiple Delivery Means" (Fort Belvoir, VA: November 1964): 4, and Table 1, p A-3.

42. Major Geoffrey G. Prosch, "Israeli Defense of the Golan," Military Review, October 1979: 6

43. Starr, 46.

44. U.S. Department of the Army, ARTEP 7-15: Training and Evaluation Program for Infantry Battalions (Washington: June 1979): 13-11-1.

45. LTC Alan R. Cocks, "Objective: NTC," Armor, July August 1986: 12.
46. U.S. Army Center for Army Lessons Learned, "Observation # 199 at the National Training Center," October 1985.(CALL # 1020)
47. John M. Deponai III, "The Obstacle Planning Simulation," Military Engineer, no 50 (August 1985): 458-459.
48. U.S. Department of the Army, Field Manual 20-32: Employment of Land Mines (Washington: July 1955): 76.
49. U.S. Department of the Army, Field Manual 5-32: Land Mine Warfare (Washington: May 1949): 138-141.
50. V. Jastrebov, "Landmines as a Means of Destroying the Enemy," Military Engineer (January 1943): 28.

BIBLIOGRAPHY

BOOKS

1. Carver, Michael. El Alamein. New York: MacMillan and Company, 1962.
2. Esposito, Vincent J., ed. West Point Atlas of American Wars Vol II. New York: Praeger, 1959.
3. Hart, Liddell, ed. The Rommel Papers. New York: Harcourt, Brace, and Company, 1953.
4. Hart, Liddell, Fritz Bayerlein, and G.P.B. Roberts. A Battle Report: Alam Halfa. Quantico, VA. Marine Corps Association, 1956.
5. Insight Team of the London Sunday Times. The Yom Kippur War. New York: Doubleday, 1974.
6. Phillips, C. E. Lucas. Alamein. London: Heinemann, 1962.
7. Playfair, I.S.O.. A History of World War II: The Mediterranean and Middle East, Vol IV. London: Her Majesty's Stationery Office, 1966.

PERIODICALS

1. Alder, Konrad. "Modern Land Mine Warfare." Armada International 6, November/December 1980: 6-18.
2. Bingham, Price T. Lt Col. "NATO Needs a New Air Interdiction Approach." Armed Forces Journal, October 1986: 98-112.
3. Buschmann, Peter. "The Mobile Barrier - Land Mine Warfare in the 90's." NATO'S Sixteen Nations, vol 31, July 1986: 54-57.
4. Campbell, James L. Major. "Obstacles." Infantry, May-June 1976: 12-13.
5. Cocks, Alan R. LTC. "Objective: NTC." Armor, July-August 1986: 11-19.

6. Crevecoer, Pierre Lt Col. "Second Generation AT round Mines " Armada International, 11 July 1985: 45-51.
7. Crosthwait, M. L. Major. "Demolitions and Minelaying- Some German Methods." Military Review, October 1952: 76-82.
8. Deponai, John M. III. "The Obstacle Planning Simulation." Military Engineer no 50 (August 1985): 458-459.
9. Fastabend, David A. Major, and Major Ralph H. Graves. "Manuever, Synchronization, and Obstacle Operations " Military Review February 1986: 36-48.
10. Gass, N. "Exiting Mined Areas." Ubique no 31 (n.d.): 7-9.
11. Geisenheyner, Stefan. "Some Observations on Mine Warfare." Asian Defence, no 4, July- August 1980: 73-76.
12. Harrison Don, "Budget Offices See Hard Choices for Army " Army Times 2 february 1987: 33
13. Hill J. R. Col. "Sappers in the Falklands " Military Engineer no 493 (May-June 1984): 162-166
14. Jastrebov, V. "Land mines as a Means of Destroying the Enemy." Military Engineer (January 1943): 25-28.
15. Kem, Richard S MG "E-Force." Engineer, Spring 1986: 10-15.
16. Kosco, William G LTC. "The 1973 Middle East War-An Engineer's View." Military Engineer no 464 (November-December 1979): 394-399.
17. "Mine Warfare (1), The Lessons of Two World Wars." Defence Update, no 67, 1985: 12-47.
18. Ozolek, David J. Major. "Barrier Planning " Armor, November-December 1985: 14-18.
19. Prosch, Geoffrey G. Major. "Israeli Defense of the Golan." Military Review, October 1979: 2-8.
20. Safran, Nadav. "Trial by Ordeal: The Yom Kippur War, October 1973 "

International Security no 2 (Fall 1977): 133-150.

21. Schnaufl, Wolfgang. "Minefields: New Orientations for Their Utilization " Defence Today, February 1980: 42-45.
22. Sloan, C. E. Major. "Battle Baffles or Obstacles on the European Battlefield." The Royal Engineer Journal (February 1985): 42-45.
23. Stampfer, Rudi Major. "Restricting the Enemy's Movements: Mines." trans. Soldat und Technik, Vol 24, 1981: 80-88
24. Starr, Douglas H. Major. "This Land Is Mined Land- Or Should Be." Armor, May-June 1977: 44-48.
25. Toomey, Charles L. LT. "Obstacle Planning " Armor, March-April 1979: 43-46.
26. Williams, Peter. "The Role of Artillery." NATO'S Sixteen Nations, no 7, November 1986: 50-55.
27. Von Sandart, Hans LTG. "Forward Defence- Mobility and the Use of Barriers." NATO'S Sixteen Nations, vol 30, February-March 1985: 37-43.

GOVERNMENT PUBLICATIONS

1. U.S. Army Engineer Center and School. Engineer Center Team Minutes. No 86- 6 Fort Belvoir, VA: June 1986.
2. U.S. Army Engineer Center and School. Handbook of Employment Concepts for Mine Warfare Systems. Fort Belvoir, VA: August 1986
3. U.S. Army Training and Doctrine Command. Pamphlet 525-18, U.S. Operational Concept for Countermine Operations. Fort Monroe, VA. 30 June 1982
4. U.S. Army Training and Doctrine Command. Pamphlet 525-19:U.S.Army Operational Concept for Land Mine Warfare. Fort Monroe, VA: 18 June 1982.

5. U.S. Army Training and Doctrine Command. Pamphlet 525-43: Joint Operational Concept for Coordination of Employment of Air Delivered Mines. Fort Monroe, VA: 26 September 1984.
6. U.S. Army Training and Doctrine Command. Pamphlet 525-45: General Operating Procedures for Joint Attack of the Second Echelon. Fort Monroe, VA: 31 December 1984.
7. U.S. Army Training and Doctrine Command. Pamphlet 525-49: U.S. Army Operational Concept for Ammunition Support on the Airland Battlefield. Fort Monroe, VA: 17 January 1986.
8. U.S. Army War College. Forces/Capabilities Handbook, Vol II: Weapons Systems. Carlisle Barracks, PA: 1987.
9. U.S. Army War College. Reference Text: Soviet Armed Forces. Carlisle Barracks, PA: 1987.
10. U.S. Department of the Army. ARTEP 7-15: Army Training and Evaluation Program for Infantry Battalions. Washington: June 1979.
11. U.S. Department of the Army. Field Manual 1-104: Forward Arming and Refueling Points. Washington: 31 July 1985.
12. U.S. Department of the Army. Field Manual 5-30: Engineer Field Manual: Obstacle Technique. Washington: 30 June 1943.
13. U.S. Department of the Army. Field Manual 5-32: Land Mine Warfare. Washington: May 1949.
14. U.S. Department of the Army. Field Manual 5-100: Engineer Combat Operations. Washington: May 1984.
15. U.S. Department of the Army. Field Manual 5-102: Countermobility. Washington: March 1985.
16. U.S. Department of the Army. Field Manual 20-32: Employment of

Land Mines. Washington: July 1955.

17. U.S. Department of the Army. Field Manual 20-32: Mine/ Counter-mine Operations. Washington: 9 December 1985.
18. U.S. Department of the Army. Field Manual 34-3: Intelligence Analysis. Washington: January 1986.
19. U.S. Department of the Army. Field Manual 34-80: Brigade and Battalion Intelligence and Electronic Warfare Operations. Washington April 1986.
20. U.S. Department of the Army. Field Manual 71-1: The Tank and Mechanized Infantry Company Team. Washington: 30 June 1977.
21. U.S. Department of the Army. Field Manual 71-2: The Tank and Mechanized Infantry Battalion Task Force. Washington: 30 June 1977.
22. U.S. Department of the Army. Field Manual 71-3: Armored and Mechanized Brigade Operations. Washington: 25 July 1980.
23. U.S. Department of the Army. Field Manual 71-10: Infantry Rifle Company. Washington: 8 January 1982.
24. U.S. Department of the Army. Field Manual 71-20: The Infantry Battalion. Washington: 28 December 1984.
25. U.S. Department of the Army. Field Manual 71-100: Armored and Mechanized Division Operations. Washington: 30 March 1979.
26. U.S. Department of the Army. Field Manual 100-5: Operations. Washington: 5 May 1986.
27. U.S. Department of the Army. Field Manual 100-2-1: The Soviet Army Operations and Tactics. Washington: 16 July 1984.
28. U.S. Department of the Army. Field Manual 100-2-3: The Soviet Army Troops, Organization, and Equipment. Washington: 16 July 1984.
29. U.S. Department of the Army. Field Manual 100-10: Combat Service Support. Washington: 1 March 1983.
30. U.S. Department of the Army. Field Manual 101-10-1: Staff Officer's

Manual Organizational, Technical, and Logistic Data. Washington: 1 July 1976.

31. U.S. Department of the Army. Training Circular 6-20-5: Field Artillery Delivered Scatterable Mines. Washington: 8 January 1982.
32. U.S. Department of the Army. Training Circular 20-32-1: Hasty Protective Mining. Washington: 15 August 1975.
33. U.S. Department of the Army. Training Circular 20-32-2: Employment of the M 56 Helicopter Delivered Mine System. Fort Belvoir, VA: 30 September 1976.
34. U.S. Department of Defense. Joint Chiefs of Staff Publication 1: Dictionary of Military and Associated Terms. Washington: 13 January 1986.
35. U.S. War Department. Military Intelligence Service Tactical and Technical Trends No. 32. Washington: 26 August 1943.

MANUSCRIPTS

1. Ejercito Argentino. Conflicto Malvinas, Tomo I, II. Buenos Aires: 7 July 1983.
2. Engineer Agency for Resource Inventories. Land Mine and Countermine Warfare, North Africa 1940-1943, and North Africa Appendixes. Washington: June 1972.
3. Engineer Agency for Resource Inventories. Land Mine and Countermine Warfare, Eastern Europe World War II. Washington: August 1973.
4. Engineer Agency for Resource Inventories. Land Mine and Countermine Warfare, Western Europe World War II. Washington: July 1973.
5. Engineer Agency for Resource Inventories. Land Mine and Countermine Warfare, Italy 1943-1944. Washington: June 1972.
6. Engineer Agency for Resource Inventories. Land Mine and Countermine Warfare, Korea 1950-1954, and Korea Appendixes I, II, III. Washington: June 1972.

7. Engineer Studies Group, Office of the Chief of Engineers. Measuring Obstacle Effectiveness: A Fresh Perspective. Washington: March 1975.
8. Historical Evaluation and Research Organization. Historical Evaluation of Barrier Effectiveness. Dunn Loring, VA, March 1974.
9. McLean Research Center, Inc. Barrier 2000: An Evolutionary Concept Aimed Toward Airland Battle 2000. 28 February 1983.
10. Parr, Arthur J. Major, "Soviet Combat Engineer Support." U.S. Army Institute for Advanced Russian and East European Studies, Garmisch Germany, 1 April 1978.
11. Toppe, Alfred. "Demolition and Mining" Manuscript, Historical Division, U.S. Army Europe, 1953. (OCMH MS P-074.)
12. U.S. Army Combat Developments Command. A Study of Packaging of Field Fortification and Barrier Materials for Multiple Delivery Means. Fort Belvoir, VA: November 1964.
13. U.S. Army Combat Developments Experimentation Command. Tactical Effectiveness of Minefields in the Antiarmor Weapons System. Fort Ord, CA: June 1977.
14. U.S. Army Center for Army Lessons Learned. CAC and FL Forms 1357 Observations and Assessments at the National Training Center. Fort Leavenworth, Kansas.
15. U.S. Army Material Systems Analysis Activity. Results of Armored Platoon Effectiveness Test, Phase I. Aberdeen, Maryland: September 1986.

END

8-87

DTIC