A box in the desert: using open access satellite imagery to map the 151st Infantry Brigade's field defences on the Gazala Line, 1942

Abstract

At the end of May 1942, the Axis *Afrika Korps* launched an assault on the Allied Eighth Army's defences of the Gazala Line in Libya: the Gazala Line was located to the west of Tobruk, and stretched south into the Libyan desert. By the time the Axis attacked the Gazala Line, the Allies' defences consisted of a series of boxes which were defended by the different brigades of the Eighth Army. In this article, the results of a survey of the field defences of the 151st Infantry Brigade using open access satellite imagery is discussed. This research will demonstrate that the 151st Infantry Brigade's box was primarily designed to defend against a frontal assault. In addition, the survey demonstrates the value of open access satellite imagery for understanding Second World War desert battles.

Keywords: Gazala; conflict archaeology; Google Earth.

Introduction

In recent years, there has been a wealth of research into twentieth-century conflict archaeology. These studies range from focusing on the physical remains associated with conflict to research that takes a more theoretical approach to issues surrounding recording and interpreting sites (see Dobinson 2001, 2010, 2013; Schofield et al. 2002; Cocroft et al. 2004; Schofield 2005; and Osborne 2008). This body of work has demonstrated that research into the physical legacy of modern conflict can contribute to both academic and public understandings of past events. In addition, modern conflict archaeology can help unpack the social memories of past wars (see Harrison and Schofield 2010).

Archaeological studies of the Second World War have now expanded beyond the confines of the battlefields of the European Theatre of Operation. Research has now been conducted on the Pacific Theatre (see Jeffery 2004; Dixon et al. 2012; Price and

Knecht 2012; Price et al. 2013; Browne 2014; McKinnon and Carrell 2015; Browne 2019; and Young 2012), as well as in the Americas (see Shew and Kamp-Whittaker 2013; Ng and Camp 2015; Barnes 2018a; and Barnes 2018b). The Second World War, however, also turned vast areas of North Africa into a conflict zone. Although several studies have been conducted on sites across Africa, few have focused on the physical remains of the Second World War (see Sinclair-Thomson and Challis 2017; Gilbin 2015; Pollard et al. 2005; Chipangura and Silika 2019; Swanepoel 2005; Banks 2007; Bolin 2012; Garfi 2014). Moreover, the limited archaeological work that has been undertaken on the North Africa Campaign has focused on the Battles of El Alamein (see Pearson & Connah 2009; Bondesan 2012; Bondesan et al. 2013).

This article seeks to contribute to this growing body of work on North African conflict archaeology through a discussion of the 151st Infantry Brigade's defensive 'box' on the Gazala Line constructed in 1942. Until recently, the Battle of Gazala has been overlooked in the historiography of the Second World War. The battle is often regarded as part of the wider discussion of the Allied retreat from El Agheila to El Alamein and is overshadowed by the Second Battle of El Alamein (Dando 2014: 112). Historians who have examined the Battle of Gazala have previously never mentioned the physical remains. It is possible that this oversight was partly due to the challenges in conducting fieldwork in Libya, and also the absence of a suitable methodological approach for undertaking a remote survey. This article will begin to address this oversight by exploring the physical remains of the Gazala battlefield within the Libyan landscape.

The defensive 'box' of the 151st Infantry Brigade, which formed part of the 50th Infantry Division's area of responsibility on the Gazala Line from the end of February 1942 until the *Afrika Korps'* attack in May 1942, will be the focus of this study.

Diversional attacks to the north and south of the 151st Infantry Brigade's box during the Battle of Gazala meant that the brigade did not see any major fighting. In addition, as the site of their box had not been fought over prior to, during, or after the battle, the field remains that are still visible on open access satellite imagery must date from the activity in February to May 1942. As the box was located on an open, flat plain, the topography would have had limited influence on the siting of the brigade's field defences and their position was clearly dictated by tactical considerations.

Methodology

The transcription of the field defences presented in this article was undertaken by a systematic visual survey of open access satellite imagery covering the 151st Infantry Brigade's box in northeast Libya. It was the objective of the survey to create a data set which contained information on the field defence placement, the number of positions, and their nature. To ensure a systematic approach to the survey, a 1km-by-1km grid was laid over the entire area. Each grid square was then methodically examined at a viewing altitude of 500m. This viewing altitude was selected as it was the maximum height which still allowed for confidence in detecting and identifying all field remains. At this viewing altitude the smallest features that can be reliably recorded are 3m in size. Although these features can be recorded at a 500m viewing altitude, the resolution of the satellite images are insufficient to assess the precise function of these features (Figure 1). All historic satellite imagery available on Google Earth were consulted as the resolution, environmental conditions, or position of the sun meant that archaeological features were not visible on every image (Figure 2). Once a feature had been identified, it was transcribed in ArcGIS at 1:1000 using Maxar Vivid imagery as a guide.

Once the field defences were transcribed from the satellite images, fields of fire were plotted. The first attempt at plotting Second World War fields of fire was undertaken by Colin Lacey in 2003. In Lacey's study, variations in natural terrain were taken into account when determining fields of fire. Comparatively, for this study, variations in topography were assumed to be negligible and have no impact on fields of fire. The Libyan desert in the region around the Gazala Line is predominantly a flat plain. Although there will be some variation, changes in topography would reduce the fields of fire. In this article, a perfect 360^{o} field of fire and line of sights has been assumed as this demonstrates the maximum defensive area surrounding the field defences.

With the introduction of open access remote sensing technologies, such as Google Earth, some aspects of desktop surveying have become more accessible (O'Reilly and Scott 2015: 9). Although the data available from Google Earth is not always a substitute for higher-resolution imagery that is available to purchase, the software reduces costs, and is easier to use and access (Myers 2010: 457). Since the release of Google Earth, various studies have demonstrated the value of the platform for discovering new archaeological sites in remote and inaccessible regions (see Luo et al. 2018; Myers 2010; O'Reilly and Scott 2015; Kempe and Al-Malabeh 2013; Thomas et al. 2008; Sadr and Rodier 2012; and Kennedy and Bishop 2011). Work by Salvatore Garfi on the fortifications of the Spanish Civil War has also demonstrated the value of Google Earth for the study of Modern Conflict Archaeology (Garfi 2019, 19, 38). One of the aims of this study is to contribute to this growing body of literature.

Historical background

By Christmas 1941, following the advance of the Eighth Army during Operation CRUSADER, General Erwin Rommel's *Afrika Korps* had been forced to withdraw to

Agedabia in northwest Libya (Figure 3). Cyrenaica, the eastern coastal region of Libya was now under Allied control. Following Rommel's retreat, General Sir Clause Auchinleck, Commander-in-Chief Middle East Command, believed the *Afrika Korps* would be unable to launch a counterattack for some time. Any attack Rommel might have launched was anticipated by the Allies to be localised and containable. However, the German reinforcements that arrived from Tripoli, combined with the Italian tanks at their disposal, meant that the *Afrika Korps* outnumbered the Eighth Army much sooner than the Allies had expected (Doherty 1999, 35-6).

Based on the number of Axis reinforcements arriving in Libya, Rommel was advised that for the two weeks following 12 January 1942, the *Afrika Korps* would be stronger than the Allies, whom were also reportedly getting short on supplies (Graham 1999, 96). Taking into account all the information at his disposal, Rommel decided to go on the offensive (Carver 1964, 148). On 21 January 1942, Rommel launched an attack from his positions near Agedabia, which threw the Allied 1st Armoured Division into a state of confusion (Carver 2002, 56). Realising that he had caught the Allies by surprise, Rommel decided to continue the attack by launching a fresh assault on the Allied positions on 27 January (Doherty 1999, 35, 37).

Following the loss of Benghazi to Rommel on 29 January 1942, formations within the Allied Eighth Army were instructed at 14:00 on 1 February to begin their withdrawal to the Gazala Line the following day (Graham 1999: 96; Carver 2002: 58; and TNA WO 201/2696: 29). Within a few days, the Eighth Army had arrived back at Gazala (TNA CAB 44/97: 15). Initially, the Allies had conceived the position at Gazala as an outpost line intended to delay the eastward movement of the *Afrika Korps* for as long as possible, with their main defensive position stretched along the Libyan-Egyptian border (TNA WO 236/2a: 1). Consequently, between February and March 1942, the

Gazala Line was only being defended by a small number of formations, whilst the Allies evacuated the stores held in Tobruk (TNA WO 236/2b: 1-2).

At some point in February or March 1942, the Allies decided to both build up their defences on the Gazala Line and around Tobruk, and create a striking force behind the defended positions (TNA CAB 44/97: 19; TNA CAB 44/418a: 2; TNA WO 236/2a: 1; and TNA WO 236/2b: 1-2). The Eighth Army was also ordered to take the offensive at the earliest possible date (TNA WO 236/2a: 1). It was the intended aim of this Allied offensive to relieve the pressure on Malta as 'the Navy insisted that the Cyrenaican "bulge" must be captured to prevent its use by enemy aircraft and to enable us to base air escorts for the [Malta] convoy on the landing grounds' (TNA WO 236/2b: 1). As the number of troops and tanks at Rommel's disposal was rapidly increasing, the Allies decided that the Eighth Army would receive his attack in its defended position at Gazala, before launching a strong counterattack (TNA WO 236/2a: 1). The Allies determined that in order for their plan to succeed, they would need to build up a superior ratio of tanks of 3:2, in addition to another fifty percent of tanks in reserve (TNA CAB 44/97: 42). Tobruk essentially became a military depot holding the supplies for the Allies' planned counter offensive. To secure these stores and to protect against Rommel's anticipated attack, the Gazala Line had to be strengthened (TNA CAB 44/97: 16). Eventually, on 26 May 1942, the *Afrika Korps* launched their attack against the defended boxes established by the Allies on the Gazala Line.

Field remains

The Allies' defences on the Gazala Line were intended to block the western approach to Tobruk and all routes from Segnali, which would force Rommel's forces to the south and into the desert if the *Afrika Korps* tried to outflank the position (TNA CAB 44/97: 33). Each Allied brigade on the Gazala Line developed defensive 'boxes' which were

surrounded by barbed wire and minefields (Figure 4) (TNA CAB 44/420: 6). When the 151st Infantry Brigade arrived in the centre of the Gazala Line in late February 1942, the brigade's formations began work on improving, digging, and camouflaging the fighting positions and living quarters within their box (Figure 5) (TNA WO 169/4288a: 1; TNA WO 169/5007a: 6; TNA WO 169/5008a: 2; and TNA WO 169/5008b: 2). The units making up the 151st Infantry Brigade were the 6th Battalion, 8th Battalion, and 9th Battalion Durham Light Infantry, in addition to C Company, 2nd Battalion, Cheshire Regiment, and the guns of the 74th Field Regiment Royal Artillery (RA), the 65th Anti-Tank Regiment Royal Artillery (TNA WO 169/4722: 1), and the 25th Light Anti-Aircraft Regiment (TNA WO 169/4882: 2). The systematic survey of the Libyan landscape identified various field positions constructed by the 151st Infantry Brigade which will now be discussed (Figure 6).

Defensive positions

The infantry training pamphlet produced by the War Office in 1944, two years after the Battle of Gazala, stated that when a battalion was developing a defensive position, the 'digging of shelter slits and weapon pits to provide cover for every man in the battalion will be the automatic first task of the troops' (The War Office 1944a: 39). In the sector to the west of the 151st Infantry Brigade, which was held by the 150th Infantry Brigade, field position construction was slow due to the hard nature of the ground, and the soldiers were only equipped with picks and shovels (TNA WO 169/4999a: 1). Despite gradual progress, 'great care was taken to site the positions where they could best do their task and rather than go to a place where digging was easier [they] have persevered on the spots originally chosen' (TNA WO 169/4999b: 2). Although the ground was hard in the vicinity of the 151st Infantry Brigade's box, the brigade's troops continued digging and improving their field defences up until Rommel launched his attack on the

Gazala Line (TNA WO 169/5007b: 6; TNA WO 169/5007c: 4; TNA WO 169/5007d: 4; and TNA WO 169/5008c: 9). One of the most basic defensive positions of the British Army during the Second World War was the 'Weapons Pit' which could accommodate 2 men and was 3ft 6in (1.1m) wide by 6ft (1.8m) long. Several weapons pits would then be connected by a zig-zag trench to create a 'Sections Post' that could accommodate between 8-10 men, and was designed to provide all round defence (TNA WO 169/4999c: 1 and TNA WO 169/5007b: 6). Three Section Posts would then be joined together with fire trenches to create 'Platoon Posts' (The War Office 1944b: 41). Open access satellite imagery indicates that the main defensive features in the 151st Infantry Brigade's box were platoon posts formed of trenches which ranged from 70-200ft (21-61m) in length and arranged in a zig-zag formation (Figure 7). The platoon posts were also arranged into groups of 3, which formed a company's defensive position, with each battalion made up of 3-4 companies. Tripwires, laid to a depth of 12-15yds (11-14m), with tactical wire beyond, surrounded each of these posts (TNA WO 169/4999c: 1).

Each battalion in the brigade was responsible for the security of its own front (TNA WO 169/4288c: 1). To provide advance warning of an attack, small outposts, probably formed of several 2-man weapons pits, were constructed beyond the box (TNA WO 169/5007c: 2). It was the task of these outposts to 'deny the enemy close reconnaissance of the main defended area, … [and] to delay the enemy and force him to mount an attack on the outpost line, thus acting as a cushion in front of the main defences' (The War Office 1944a: 44). Beyond the outposts, the 151st Infantry Brigade's box was also screened by 'armoured car patrols and small mobile columns, which prevented the enemy from reconnoitring the defensive positions and minefield' (TNA WO 231/93: 9).

Artillery

In support of the infantry, the box of the 151st Infantry Brigade was also defended by elements of the 74th Field Regiment Royal Artillery, 65th Anti-Tank Regiment Royal Artillery (TNA WO 169/4722: 1), and the 25th Light Anti-Aircraft Regiment (TNA WO 169/4882: 2). The primary tasks of the light anti-aircraft troops attached to the 50th Infantry Division was the defence of the 25-pounder batteries. As such, at least two troops were deployed to each of the 50th Infantry Division's brigades. The guns of each troop were then sited to ensure a good all-round field of fire (TNA WO 169/4882: 2). In addition, alternative sites were selected which took 'advantage of natural features to get their gun into more "hull down" position with the required A/Tk [anti-tank] field of fire of about 400/600 yds [366-549m]' (TNA WO 169/4882: 2). Observation posts were also established to provide advance warning of enemy tanks so that the light anti-aircraft guns had time to relocate to alternative positions (TNA WO 169/4882: 2).
It was the recommendation of the 25th Light Anti-Aircraft Regiment that gun pits should be partially dug-in with walls raised 2ft (0.6m) above the ground level. These walls should then be carefully camouflaged with the surroundings and faced with rock, rubble, or cement (TNA WO 169/4882: 2). Although various gun emplacements have been identified from satellite imagery, it has not been possible to positively identify any as light anti-aircraft gun pits.

Within the 151st Infantry Brigade's box, 14 artillery positions have been identified from satellite imagery (Figure 8). Each of these positions comprised 4 gun pits that each supported a single troop. The artillery was mainly positioned 700-2000yds (640-1829m) behind the box's western edge, with the exception of three troop positions located in the north-eastern sector. Each of the 25-pounder gun pits were 36ft (11m) in diameter, which was slightly larger than the 27ft (8.2m) minimum diameter set out in

the *Middle East Training Pamphlet No. 16*, and were designed to allow 360º arcs of fire (TNA WO 169/4147: 2).

In addition to the 25-pounders, and the light anti-aircraft guns which could also operate in an anti-tank role, the 151st Infantry Brigade's box was also protected by the anti-tank guns of the 65th Anti-Tank Regiment Royal Artillery (TNA WO 169/4722: 1). A sketch plan of the defences within the box shows that the anti-tank guns were predominately positioned along the western edge to protect against a frontal attack (Figure 5). It was recommended that the gun pits for 6-pounder anti-tank guns were 1ft 6in (0.5m) deep, 18ft in diameter (5.5m), with no parapet, and an irregular slope to avoid shadow (TNA WO 201/2960: C2). Construction of the anti-tank gun pits in the 151st Infantry Brigade's box were completed by the beginning of March 1942 (TNA WO 169/4709: 1). Although several features which could be isolated gun emplacements were recorded, no anti-tank gun pits were positively identified by this survey. It is possible that anti-tank gun pits are not clearly visible on satellite imagery due to a lack of parapet. Anti-tank gun pits would, therefore, be relatively indistinguishable from the surrounding area on satellite imagery as they create little shadow.

Dummy positions

Battalion standard guidance issued by the War Office in 1944, two years after the Battle of Gazala, stated that '[c]oncealment in defence helps to evade accurate air attack, and denies to the enemy detailed knowledge necessary to his ground attack' (The War Office 1944a: 40). The orders issued to the units within the 151st Infantry Brigade's box before the battle, stated that dummy positions 'must be made to look real. They will frequently be lived in and must include dummy weapons. They must NOT be close to real posns [sic]' (TNA WO 169/4288d: 1). This survey identified one dummy position for a troop of four 25-pounders in the centre of the 8th Battalion Durham Light Infantry

sector, which corresponds with a dummy position marked on a map of the 8th Battalion Durham Light Infantry's defences (TNA WO 169/5008d). Approximately 500yds (457m) to the northeast of a genuine position, the four dummy gun emplacements are arranged in a crescent with each pit between 58-70yds apart (53-64m). The internal diameter of each of these dummy positions is 27ft (8m), which was slightly smaller than the dimensions set out in the *British Middle East Training Pamphlet No. 16, Design and Lay-Out of Field Defences* (1943) (Figure 9). The 505th Field Company Royal Engineers were also tasked with creating 'flashes' in these decoys to draw enemy shellfire (TNA WO 169/5312a: 4).

It is difficult to determine which fieldworks in the box were constructed as dummy positions as they were laid out to look like active positions. Battalion guidance recommended that over half of the field defences should be constructed as dummy positions (The War Office 1944a: 40). In addition, some fieldworks were constructed as alternative fighting positions. When D Company, 8th Battalion Durham Light Infantry, relieved B Company on the left-hand sector of the box, the former used B Company's defences as alternative positions, but these could also have acted as dummies (TNA WO 169/5007b: 2).

Near-contemporary training manuals stated that battalion defences should include dummy minefields which should have a 'proportion of live mines along the enemy edge. Reasonable attention should be drawn to it by indifferent siting and moderately concealed wire. The apparent strength of anti-tank guns covering it may be increased by dummy positions' (The War Office 1944a: 40). Maps of the 151st Infantry Brigade's defences indicate that dummy minefields were developed to the west of the 6th Battalion Durham Light Infantry's position (TNA WO 169/5007d: 3). Due to dummy and alternative defences being constructed in the same manner as the actual

fighting positions, it is difficult to positively distinguish between them on satellite imagery.

Minefields

During the Second World War, minefields were one of the quickest forms of artificial obstacles battalions could construct: these had the 'advantage that they can be laid where they are wanted to fit in with other defences. They can be rapidly set up, and can often be concealed from the enemy and so be used as a means of surprise' (The War Office 1944a: 36). The primary minefield extended along the whole length of the Gazala Line. In the sector held by the 1st South African Division, the primary minefield was 200yd (183m) wide and consisted of 150,000 anti-tank mines laid at a density of 2.5 mines per 1 yard (0.9m) (TNA CAB 44/97: 34). Although the density of the minefield in front of the 151st Infantry Brigade's box is unknown, mines were sown 1 mine per 0.75-1yd in front of the 150th Infantry Brigade's box (TNA WO 169/4287a: 1). Along the most likely axis of the *Afrika Korps'* approach, minefield 'marshes' were laid out, and the 50th Infantry Division identified the area to the west of the 151st Infantry Brigade's sector as a priority (TNA CAB 44/97: 34 and TNA WO 169/4287b: 4). Alongside the anti-tank mines, the Eighth Army also sowed anti-personnel mines (TNA CAB 44/97: 34). To allow the troops defending the Gazala Line safe passage through the minefields, gaps were left. Royal Engineers were stationed near to each of these gaps in order to close them in the event of an attack (TNA WO 169/5007c: 2). The edges of the minefields were also marked by trip wires and pickets (TNA WO 169/4147: 1). Work on developing the minefields surrounding the 151st Infantry Brigade's box continued from late February until the Battle of Gazala (TNA WO 169/4147: 1; TNA WO 169/4288d: 1; TNA WO 169/4287b: 4; TNA WO 169/4287c: 12; TNA WO 169/4287d: 18; TNA WO 169/5312a: 1, 4; and TNA WO 169/5312b: 2).

It was not possible to identify the minefields of the 151st Infantry Bridge from open source satellite imagery.

Logistics/vehicle pits

Access to food, water, supplies, and transportation were essential to units operating in deserts. Despite guidelines stating that '[p]osts should be self-contained and capable of an independent existence' (TNA WO 201/2960: 1), within one sector of the box, held by the 6th Battalion Durham Light Infantry, all stores, with the exception of No. 11 Platoon B Company's trench stores and reserve rations, were 'brought into a central dump and guarded under Coy arrangements' (TNA WO 169/5007e: 1). The location of the central dump could not be identified in this study, but it might be represented by one of the clusters of vehicle pits and other small features. Within the eastern sector of the 151st Infantry Brigade's box, and to the rear of the Brigade's HQ, a 'harbour' for the motor transport was organised (TNA WO 169/5007b: 3). In addition, orders were issued stating that all vehicles within the defensive boxes were to be dug-in (TNA WO 169/4999d: 1 and TNA WO 169/5008e: 3). Satellite imagery indicates that these vehicle pits, measuring approximately 9ft (2.7m) by 22ft (6.7m), were widely dispersed across the box (Figure 10), with the greatest concentration in the eastern sector, within the Brigade's HQ and the 505th Field Company Royal Engineers areas of responsibility.

Discussion

At the centre of the Gazala Line was the 151st Infantry Brigade's box which was divided into three sub-sectors: on the right of the line was the 9th Battalion Durham Light Infantry; in the centre the 6th Battalion Durham Light Infantry; and on the left, the 8th Battalion Durham Light Infantry, each with their own supporting troops (Figure 5) (TNA WO 169/5007f: 1). Operational orders issued by the brigade stated that '151

Bde [Infantry Brigade] will hold the Bde Box to the last round and the last man' (TNA WO 169/4288e: 1). These orders also outlined a system of defence 'designed to resist attack from the WEST – N.W. – SOUTH and S.E. … Alternative posns for certain sub-units will be constructed so as to cover the EAST and N.E. portions of the perimeter' (TNA WO 169/4288e: 4). In the 6th Battalion Durham Light Infantry's sector, the alternative positions in the east were dug between the 'Sunderland Gap' and the 'Durham Gap', which were pathways left within the minefield (Figure 5) (TNA WO 169/5007f: 2). All the defences within the box were intended to be organised for all round defence and any 'attack will be stopped by fire of all arms forward of and in the minefield belt. Maximum ranges for opening fire will be 600 yds [549m] for Brens and 400 yds [366m] for rifles' (TNA WO 169/5008e: 1).

The analysis of the archaeological remains of the 151st Infantry Brigade has provided a new approach to understanding the Battle of Gazala. Field positions which were recorded from satellite imagery clearly show the brigade concentrated their defence in the north-western and southern sectors of the box. In the north-west, the 9th Battalion Durham Light Infantry positioned trenches to ensure overlapping fields of fire and in places, the fire from 7 platoon trenches overlapped (Figure 11). The battalion's western sector was clearly laid out to provide all round, mutually supporting defence. To the east, only six platoon trenches were dug by the 9th Battalion Durham Light Infantry to defend the eastern approaches to their sector's box. The ability of these troops to concentrate fire was, however, limited due to fewer overlapping fields of fire.

The defence of the 151st Infantry Brigade centre was allocated to the 6th Battalion Durham Light Infantry, and their fieldworks are more widely dispersed compared to the north-west and south of the box. In this sector, platoon trenches are

clustered in a group of 3 which could accommodate a company, with alternative positions located between 1.5 and 2 miles (2.4 and 3.2km) to the east.

In the southern sector of the 151st Infantry Brigade's box, the 8th Battalion Durham Light Infantry concentrated their defences in the south-west of their area of responsibility, with a few platoon trenches defending against a flanking attack from the east. Although the platoon trenches were designed for all round defence, the archaeology demonstrates that the 151st Infantry Brigade's box had limited protection from an enemy that had outflanked the static position.

The documentary evidence indicates that all of the anti-tank guns allocated to the 151st Infantry Brigade were positioned along the western edge of the box. The maximum range of these guns, 5,500yds (5,029m) (Henry 2004: 13), would have covered the minefield enclosing the box. There was, however, no anti-tank defence against flanking attacks coming from the north or east. The maximum range of the 25-pounders within the box, and their 360^{o} field of fire, meant that all avenues of approach could be covered. As these guns would not necessarily have a direct line of sight, observation posts would have directed the fire of the 25-pounders (Lacey 2003: 38). Although the location of the observation posts are unknown, it is presumed they were located to the northwest, west, southwest, south, and southeast in accordance with the brigade's operational orders. A flanking manoeuvre approaching 151st Infantry Brigade's box would have faced little opposition from pre-established field fortifications.

British experiences over the course of the Second World War demonstrated 'that any attempt at defence in line will not stand up against the weight of a modern attack' (The War Office 1944a: 34). Penetration by the enemy into a defended locality was accepted as inevitable, meaning any plan of defence must, therefore, 'aim at leading the

enemy into areas where he can most effectively by destroyed' (The War Office 1944a: 35). If the *Afrika Korps* had managed to penetrate the 151st Infantry Brigade's box, there were few internal obstacles that would restrict or direct their movement. It appears from contemporary plans of the defences (Figure 5) that no tactical minefields, which were laid to canalise enemy penetration within the defended area (The War Office 1943: 5), were constructed. The limited number of field defences in the northeast, east, and southeast of the 151st Infantry Brigade's box also undermined the effectiveness of the minefield as '[u]nless covered by the fire of the defenders, anti-tank mines are in most cases useless' (The War Office 1933: 44).

One of the weaknesses of the Eighth Army's Gazala Line was its length which meant that the defensive boxes were isolated from each other (TNA WO 236/2b: 2). The layout of the boxes meant that the *Afrika Korps* could surround, or ignore, each box as they wished (TNA CAB 44/97: 45). Deserts proved to have specific difficulties when planning a defence, as '[d]istances were vast; cover did not exist; the ground was usually hard rock; the creation of a defensive position, which gave any cover to the defendants, involved vast effort over several weeks and could not possibly be concealed' (TNA WO 236/2b: 3). In one British post-war analysis of the Battle of Gazala, it was stated that the adoption of the dispersed layout was due to the influence of the Joint Planning Staff at GHQ: 'They must have worked on maps of a scale of about 1/2,000,000 and thought nothing of describing positions 25 miles [40.2km] apart as "mutually supporting"' (TNA WO 236/2b: 3).

The 151st Infantry Brigade's box was approximately 1 mile (1.6km) to the west of the 69th Infantry Brigade's box and between 2 and 4 miles (3.2km and 6.4km) east of the 1st South African Brigade (Figure 4). These boxes could only support each other through indirect artillery fire as '[i]nfantry in defensive positions had no effect on what

was happening beyond the range of their observation' (TNA WO 236/2b: 3). Mapping of the field remains of the 69th Infantry Brigade's box only identified a couple of artillery emplacements. The small number of recorded emplacements suggests that the 69th Infantry Brigade could only provide limited supporting fire (Figure 12). Unlike the 151st Infantry Brigade, the positioning of the trenches also suggests that the 69th Infantry Brigade were more prepared for an attack on their rear.

Auchinleck believed that Rommel, when launching his attack against the Gazala Line, would attack the centre of the position in strength accompanied by a feint against Bir Hacheim in the south. At the time, the possibility that Rommel might envelop the Eighth Army's southern flank, before driving onto Tobruk was seen as unlikely (Carver 2002: 64). When Rommel finally launched his attack on the Gazala Line, he did just that (Carver 1964: 191). Due to the isolation of the boxes, Rommel was free to clear paths through the Gazala Line minefield to allow his supplies through (Carver 2002: 87 and Doherty 1999: 49).

Conclusion

The analysis of the field remains of the 151st Infantry Brigade's box on the Gazala Line using open access satellite images have demonstrated the nature and extent of the field defences. This study has not only demonstrated that in the centre of the Gazala Line the focus of the defence was against a frontal assault, but also the value of open access satellite imagery for understanding Second World War battlefields located in desert regions.

Declarations

Conflict of Interests The author reports there are no competing interests to declare.

Acknowledgements

I would like to thank Dr Johanne Porter for her comments on earlier drafts of this article. I would also like to thank the two reviewers for their comments which has made this a better article.

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Figure 1: Google Earth imagery for part of the Gazala Line at 250m, 500m, 750 and 1000m viewing altitude (© Google Earth).

Figure 2: Google Earth imagery of the Gazala Line date stamped as 1985, 2004, 2009, early 2012, late 2012, early 2019 and late 2019 (© Google Earth).

Figure 3: Map showing the main locations mentioned in the text (© Google Earth).

Figure 4: Map of the Gazala Line on the afternoon of 30 May 1942 (TNA CAB 44/418b)

Figure 5: Defence plan of the 151st Infantry Brigade box, 9 March 1942 (TNA WO 169/4288b).

Figure 6: Defences of the 151st Infantry Brigade's box on the Gazala Line: red represents trenches, blue are artillery positions, and black are shelters, vehicle pits, and unknown features (drawn by author, background mapping © Google Earth).

Figure 7: Three platoon trenches in the 9th Battalion Durham Light Infantry's sector, forming a company's defensive position (© Google Earth).

Figure 8: 25-pounder gun emplacement for a troop of four guns. Shelters and stores for the crews can be seen in close proximity to the gun pits (© Google Earth).

Figure 9: Dummy position for a troop of four 25-pounders was located in the centre of the 8th Battalion Durham Light Infantry's sector. 500yds (457m) to the southwest is a genuine position for four 25-pounders (© Google Earth).

Figure 10: Shelters, section posts and vehicle pits located in the eastern sector of the brigade's box (© Google Earth).

Figure 11: 151st Infantry Brigade with 400yd (366m) maximum range of engagement for rifle fire from each section trench showing overlapping fields of fire. Infantry armed with Bren guns, with an effective range of 600yd (549m), would have provided additional defensive firepower (drawn by author, background mapping © Google Earth).

Figure 12: Defences of the 69th Infantry Brigade's box on the Gazala Line: red represents trenches, blue are artillery positions, and black are shelters, vehicle pits, and unknown features (drawn by author, background mapping © Google Earth).