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3-foot ramsden theodolite from 1791 used during the principal Triangulation of Great Britain. Noe in the Science Museum, London.
Photo by User.geni, December 2008. CC-BY-SA GDFL

Allied Military Mapping of Italy during the Second World War

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Abstract. Planning for the allied invasion of Italy started in the Survey Directorate, General Headquarters, Middle East (GHQ ME), on 22 February 1943. However, British mapping of Italy had started before February 1943 as part of general mapping on Europe at small scales in anticipation of a European war. 1:1,000,000 series mapping had commenced in 1938, 1:500,000 series mapping for the Royal Air Force (RAF) in 1941 and at 1:250,000 also for the RAF in 1940. Additional 1:250,000 series for the Army and the Army and RAF were produced a little later. Topographic maps of Italy had been produced from 1941 by direct reproduction from Italian maps. Mapping of the Italian theatre, remained a largely British responsibility following the Loper-Hotine Agreement of May 1942. After a brief account of mapping activities during the Second World War, there follows a more detailed discussion of the sources, production and style of the different map series produced. It will include a discussion of the more specialised maps, such as "collation" editions, the "goings" editions and the bilingual and multi-lingual editions produced to meet the needs of Polish, Italian and French forces.

Keywords. Military Mapping, Italy, Aerial Photography, Allied Armies

Introduction

Cartographic preparations for the allied invasion of Italy started in the Survey Directorate, General Headquarters, Middle East (GHQ ME), on 22 February 1943 following an exercise at GHQ ME two days earlier.[1] The subsequent allied military mapping of Italy can be seen as a forerunner of the far larger enterprise prior to the invasion of Normandy in 1944 and a development of some of the mapping pioneered for Operation Torch, the invasion of North-West Africa, and in the fighting in the Western Desert.

1 R.E. Fryer, *Survey Notes on Operation "Husky" 22 Fb to 10 Jul 1943*, Survey Directorate G.H.Q. Middle East Force, Egypt, 1943, p. 1.

Allied military mapping of Italy did not start in 1943, some mapping had been carried out by both the British and the French during the First World War when they had been allies of Italy in fighting the Central Powers. This mapping was of limited extent and largely focussed on the frontline areas in the Dolomites. The Service Géographique de l'Armée maintained 1:1,000,000 general mapping of Italy as part of its general map of Europe.

Primary responsibility for the mapping of Italy, and the rest of Europe, lay with the British following the Loper-Hotine Memorandum of Agreement of May 1942. In this agreement Herbert B. Loper (Chief of the Intelligence Branch of the Chief of Engineers U.S. Army) and Martin Hotine (Director of Military Surveys, War Office) it was decided to divide the world for mapping purposes between the two allied powers to avoid duplication of effort[2]. The maps and reprographic material would be exchanged to permit each ally to produce maps themselves, if required. For example the United States would produce maps locally using British material for pre-operational use in the United States, such as prior to Operation Torch, the invasion of North-West Africa.

Production of maps for the Italian theatre was carried out at a number of different locations during the course of the war. Much of the basic mapping was carried out by the Geographical Section, General Staff (G.S.G.S.) at various production sites in Great Britain. These maps normally carry a G.S.G.S. number, but most of the mapping for Operation Husky (the invasion of Sicily) was carried out by the Survey Directorate, G.H.Q. Middle East Force, based in Egypt. This mapping normally carry a Middle East Drawing and Reproduction (M.D.R.) number, or more rarely an Egypt Drawing and Reproduction (E.D.R.) number. Once an Allied Forces Head Quarters was established in North Africa map production from attached survey units was given an A.F. number. AF numbers continued to be used once the Allied Forces Head Quarters moved to Italy. Some mapping is also found with a P.D.R. number. These maps were prepared by the Survey of Palestine under contract from the Survey Directorate. Like G.S.G.S. mapping, M.D.R. and E.D.R. mapping had series numbers, although M.D.R. sheets included a sheet number, for example M.D.R. 618/8657 which is the Naval Collation

2 A.B. Clough, *Maps and Survey,* War Office, London, 1952, p. 43. Clough is the definitive work on British military surveys during the Second World War, but it also has significant amounts of information on American military mapping due to the overlapping activities of the two military surveys.

Map, Edition III of Sheet 10, Avola, of the 1:25,000 mapping compiled for the invasion of Sicily. The original number of Sheet 10, Avola, is M.D.R. 618/8468. Why different styles of series designations were adopted in the Middle East and Mediterranean Theatre from those used in G.S.G.S. is not clear as it is not discussed in Clough, Fryer or G.S.G.S.[3]

Most of the mapping carried out by western allies was based or directly copied from Italian originals,[4] although there was some original 1:25,000 mapping from aerial photography from spring 1944 by the American who had multiplex plotting equipment.[5] As much of the mapping of Italy carried out during the war was based on copies of Italian originals, it was decided that name-forms would conform to local usage to avoid confusion when both redrawn and directly copied Italian maps were used. However, there were exceptions, the 1:250,000 series G.S.G.S. 3982, Europe (Air), discussed below, used English versions of place names, such as Florence for Firenze and Naples for Napoli. It is not clear why this was as the earlier 1:1,000,000 G.S.G.S 2758 Europe used local place names. Another decision was to use the South Italy Grid Zone to cover southern Italy, and the North Italy Grid Zone to cover northern Italy. The South Italy Grid extended as far north as the northern tip of Corsica and the 43rd parallel south of Firenze. Grids posed a far smaller problem in Italy than they did in the Balkan where there were multiple grids in use.[6] There was a fear that problems would be encountered as Allied forces approached the junction between the South Italy Grid and the North Italy Grid, but the advance crossed the junction so quickly in pursuit of German forces that no problems arose.

3 Clough, 1952; Fryer, 1943; G.S.G.S., *Notes on G.S.G.S. Maps of Italy Sicily, Sardinia and Corsica,* War Office, London, 1943.

4 Peter Collier and Mike Nolan, « Military Mapping by Breat Britain », in Mark Monmonier (ed.), *The History of Cartography Volume Six: Cartography in the Twentieth Century,* University of Chicago Press, Chicago, 2015, pp. 895.

5 Clough, 1952, 311.

6 Mirela Altić, « Military Cartography of WWII: The British Geographical Section of the General Staff and the US Army Map Service and their Production of the Topographical Map Series of the Balkans (1939-1945) », *Storia Militare Della Geografia* Quaderno, (2020), p. 498.

Small Scale Mapping

The first British mapping of Italy in anticipation of a possible war was the revision of the 1:1,000,000 G.S.G.S. 2758 a general map of Europe which had been started during the First World War. The Roma sheet (K-33) was revised in 1939 together with those of Palermo (J-33) and Tunis (J-32), which covered the southern half of Sardinia. The Trieste sheet (L-33) followed in 1940, but the Lyon-Milano sheet (L31 (part) & L-32) did not follow until 1942. Initially, the specification of G.S.G.S. 2758 closely resembled that of the International Map of the World, but it was subsequently changed to the "Ground/Air style with a change in the colours, replacing the green and brown for relief layers by shades of violet and an increased emphasis on features conspicuous from the air. The changes were intended to increase the map's usefulness to air crew and include colour changes to make the maps suitable for night flying. The first sheet issued in the Ground/Sir style was Lyon-Milano.[7]

Production of a map series at 1:500,000, G.S.G.S. 4072, was commenced in 1941 specifically to meet Royal Air Force Bomber Commands requirement for a map suitable for night flying. The level of detail was greatly reduced to remove features which were not essential for navigation. Layer tinting for heights used shades of violet to aid interpretation under the amber cockpit lights. The heights of mountain and hill peaks are shown prominently with the heights of the highest peaks in an area being shown in a larger font size. Woodland is shown conspicuously on this series in a mid-green as both an aid to navigation and as an obstacle to be avoided. The coverage of Italy was completed in 1942 (Fig. 1).

The existing 1:250,000 series G.S.G.S. 3982 Europe Air was extended to cover Italy with the maps being compiled between 1940 and 1942. The maps of this series were generalised for air navigation use, which made them less suitable for military use. The series was compiled primarily from the 1:250,000 Carte d'Italia, del Touring Club Italiano. The specification adopted, with brown contours was designed for use in daytime navigation (Fig. 2). G.S.G.S. 3982 was quite quickly superseded by G.S.G.S. 4230 for Italy (Fig. 3) and G.S.G.S. 3982 for Sardinia (Fig. 4). These two series were in the Army/Air style intended for use by both the Army and the Royal Air Force. The maps by direct photographic copying from the Carte d'Italia, del Touring Club Italiano. This meant that the maps were much

7 G.S.G.S, 1943, p.2.

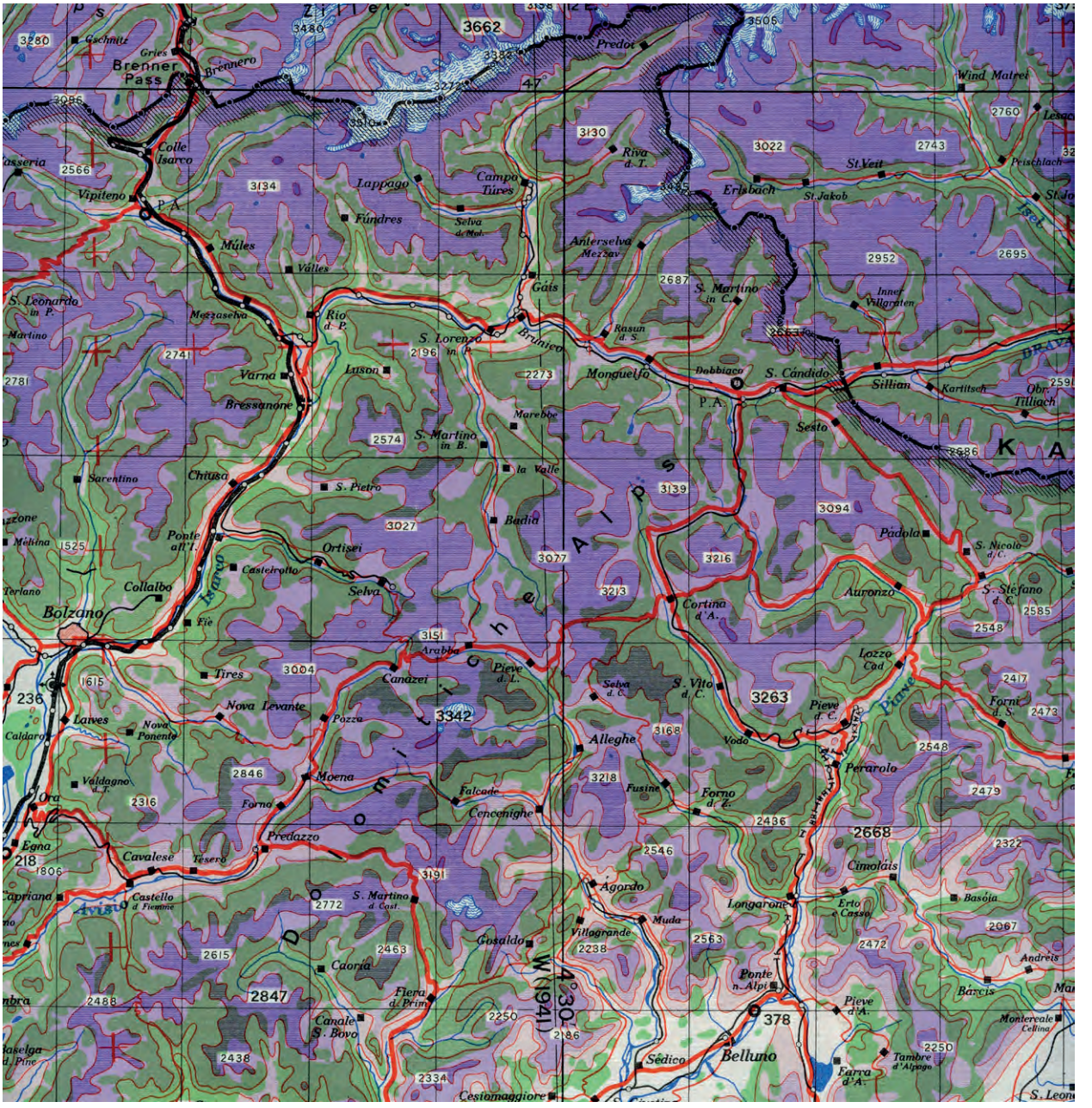

Fig. 1 Detail of the 1:500,000 Bolzano sheet (N.E. 46/10) G.S.G.S 4072 showing part of Northern Italy. The map, dated December 1941, has the distinctive colours of one made for navigation at night. (Author's collection)

Fig.2 Detail of the 1:250,000 Florence sheet (K.32/3) First Edition, G.S.G.S 3982, dated 1940, showing part of Tuscany. The map colours were designed for day-time navigation. The whole series were superseded early in the war. (Author's collection)

more detailed than those of G.S.G.S. 3982. The contours of the Italian maps were used to plot layer boundaries with layer tinting being printed in shades of violet enabling the maps to be used for night flying. The sheet lines were the same as

Fig.3 Detail of the 1:250,000 Domodossola sheet (Sheet 2) G.S.G.S. 4230 Second Edition. This example dated 1944, lacks the distinctive violet relief tints used for night navigation. (Author's collection)

those of the Italian originals. By 1 May 1943 sheets were available covering Sicily and mainland Italy south of Napoli. Seven sheets were issued for the invasion of Sicily with 30,000 copies of each printed[8].

8 FRYER, 1943, Appendix D provides a full list of all the standard maps ordered to be printed prior to the invasion of Sicily. Except for the 1:250,000 series, the Appendix lists the sheets numbers and the number of copies of each sheet to be printed. The number of overprints is not listed. Maps to the east of approximately 14° East were allocated to the Survey Directorate Middle East Force (SDMEF), those to the west of that line were allocated to Allied Forces Head Quarters (AFHQ). Unfortunately, CLOUGH (1952) only quotes global map printing numbers (just over 138 million) and does not break it down even between map scales.

Fig. 4 Detail of the 1:250,000 Sassari sheet (K. 32/II) First Edition G.S.G.S. 3982. This edition, dated 1942, was intended to be used by both ground and air forces. (Author's collection)

In 1941 a 1:1,500,000 map showing rail communications, G.S.G.S. 4176, Italy and Neighbouring Countries: Railways was issued (Fig. 5). This map was one of series produced for European countries, including neutral countries. This map was also reproduced in the United States by the Army Map Service (A.M.S.) in 1943. G.S.G.S. 4438, Europe Communications was a 1:800,000 series which covered Europe. Italy was covered by the Austria and Northern Italy sheet and the Central and Southern Italy sheet. The maps did not show relief and comprised an outline topographic map in brown, which included all place names, together with a solid light blue for the sea and lakes. This was over-printed with roads in red, railways in black and navigable waterways in a dark blue. The maps were derived from the Bartholomew 1:1,000,000 map of Europe and supplement with information from foreign official waterways maps. The waterways were classified in terms of the draughts of vessels that could use them.[9] In addition to the sheets showing all communications, printings just showing road, or railways or waterways, or any combination, were also produced.

Fig.5 Detail of the 1:1,500,000 Italy and Neighbouring Countries: Railways map published originally in 1941 as the War Office First Edition, G.S.G.S. 4176.a, this is an A.M.S. reprint from 1943. (Author's collection)

9 G.S.G.S., 1943, p.23.

1:500,000 road maps for Sicily and Sardinia were produce in preparation for the invasion of Sicily as U.S. forces were accustomed to using them while British forces used normal topographic maps.[10] To meet the needs of U.S. forces in 1943, the A.M.S. produced a 1:200,000 road map of Italy derived from the Carte d'Italia, del Touring Club Italiano. Relief was shown by hill shading in sepia. Roads were classified with steep grades shown together with distances. This map proved popular with all allied forces.[11]

Medium Scale Mapping

Initial work on the production of medium scale of Italy was started by the War Office in Britain, in late 1941, but given a low priority. This involved colour separation of the Italian 1:100,000 and copying of 1:50,000 and 1:25,000 map sheets.[12] The intention was not to print stocks in Britain, but to provide reprographic material to enable production in the Middle East if needed. This was in the form Kodalines (film negatives) or colour pulls, from which printing plates could be made. Subsequently, the War Office produced revised editions which included colour and revision from aerial photography. Initially, there was little aerial photographic cover, and much of what did exist had been taken for targeting by the Royal Air Force.

1:100,000 Scale Mapping

Of the three medium scale topographic series, the 1:100,000 is the simplest to discuss as it went through fewer changes and revisions than the 1:50,000 and 1:25,000 series. This is probably due to the series being found to be less useful except as a wall map in local headquarters. Individual sheets covered insufficient area to be useful for more strategic planning of large scale movements of bodies of troops. At the same time, the maps were too small scale and lacking in detail for ground force tactical operations and targeting by artillery. A conference held at A.F.H.Q. following the end of hostilities decided that if one of the medium scale maps had to be given up, it was the 1:100,000.[13] The chief advantage of the

10 Clough, 1952, 306.
11 Clough, 1952, 310.
12 Clough, 1952, 303.
13 Clough, 1952, 321.

1:100,000 at the start of the mapping programme was that it was the only medium scale map that covered the whole of Italy

Printing of the 1:100,000 series (G.S.G.S. 4164) by the War Office started in 1941 (Fig. 6). The first edition was monochrome, but was followed in the course of 1942 and 1943 by the second edition in four colours, black for detail, brown for contours and rock drawing, red fill for road classification, with Autostrada in solid red and the addition of filled red circles every 18mm on the map; solid red for main roads with the road number shown alongside the road also in red; other roads 5m wide or over had a pecked red fill with the pecks about 8mm long and gaps of about 3mm; secondary roads, roads 3-5m wide had red pecks with 2mm pecks and 3mm gaps, and blue for hydrology and the sea. The sea was shown in different ways on sheets of similar dates. Some sheets have a half-tone blue fill for the sea, while others have the effect of vignetting by using blue lines parallel to the shore and increasing the separation of the lines as the distance from the shore increases. All have a black military grid, with the grid numbers in blue. However, all longitudes are based on the Rome meridian, with a note on the bottom of each sheet stating that the Rome meridian is 12° 27' 7.122 east of Greenwich.

A major limitation of the 1:100,000 maps was their depiction of woods. The woods are show by small black poorly defined circles which are difficult to see on many of the maps due to their small size and colour and easy to confuse with the house symbols (G.S.G.S. 1943 7). Nine sheets of Sicily which were revised from aerial photography had woods in green with an outline as a solid line and vertical hatching broken where it would have crossed detail. The sample given in G.S.G.S. (1943) is on one of the revised sheets.

All sheets printed in Great Britain only carry the G.S.G.S. number and "Photolithographed by O.S." followed by a date. Sheets printed in the Middle East normally have M.D.R. 540/ followed by an individual sheet number and who printed the sheet, typically 512 Field Survey Company, but some printings were by 13 Field Survey Company. Sheets printed in North Africa (and later in Italy) would normally have an A.F. number and who printed the sheet. Imprints from a Lithographic Section attached to 46 Company South African Engineer Corps, and 649th Engineer Battalion of the United States Army, among others are found on A.F. numbered sheets. During the preparations for Operation Husky printing in the Middle East was delayed due to the pulls being unsatisfactory for making print-

Fig. 6 Detail of the 1:100,000 Messina-Reggio Calabria sheet (254) G.S.G.S. 4164, M.D.R. 540/7819, Second Edition dated May 1943. The M.D.R. number indicates that this sheet was printed in Egypt from reprographic material supplied by the War Office in London. (Author's collection)

ing plates and the need to obtain Kodalines instead. It was recognised that where possible only Kodalines should be used.[14] Prior to the invasion of Sicily a total of 27 different sheets were printed in a print run of 25,000 copies per sheet. One map sheet, 244 which coved the Lipari Islands, had a print run of only 5,000 copies.

All sheets carried a box to show the extent revision from air photos, but with the exception of some sheets for Sicily, this rarely, if ever, show that the sheets had been revised from air photos. Following the invasion of the Italian mainland it seems that direct air photo revision was limited to the 1:50,000 and 1:25,000 mapping. 1:100,000 sheets were, however, revised from the larger scale mapping, which had been revised from air photos. An example is Firenze Sheet 106. This map was revised in February 1944 by 661 Engineering Company (Top) U.S. Army from 2nd and 3rd editions of 1:50,000 mapping, which had been revised from air photos flown in August 1943. The sheet was then overprinted with a "Heersgitter" (a German military grid) in green. The Allied military grid has numbers in brown in the sheet margins and in red on the body of the map rather than the normal blue. The sheet also has the A.F. number cancelled and replaced by 8A Misc.3469 (i.e. 8th Army miscellaneous) and an overprinting date of July 1944 by 514 Corps Field Survey Company. The precise use of this map is unclear, but it may have been intended to be used to locate German military positions using intercepted signals.

There was some demand for layer (hypsometric) tints on the 1:100,000 maps as the contours were often difficult to interpret.[15] For areas below 100 metres no layer tint was used, with green and brown being used for layers above that altitude. As hypsometric tints were only applied to the 1:100,000 series on printings in Italy in late 1943 and into 1944, G.G.G.G. 1943 does not contain an example, nor does Clough (1952), although he does include an example from a layer tinted 1:25,000 sheet.

While there was complete Italian coverage of Italy at 1:100,000, even if not all was up-to-date, much of northern Italy, especially the Po Valley was not covered at 1:50,000, and there were gaps elsewhere, around Rome, in Sardinia and Sicily. All of these gaps were however covered by 1:25,000 maps. More of a problem was the lack of currency. While much of the north was covered by post 1930

14 Fryer, 1943, 4.

15 Clough, 1952, 309.

mapping, as was Sardinia, the west coast from Napoli to north of Roma and a significant part of Emilia-Romagna, the rest of the country was covered by pre-1920 mapping, some as early as the 1860s.[16]

1:50,000 Scale Mapping

Production of the First Edition of the 1:50,000 started in 1941 and was published by the War Office as a black facsimile of the Italian map. The only addition was the South Italian Grid. Figure 7 is from the Bronte sheet 261 II and is typical of the quality of the reproductions. Like many of the sheets of areas which had seen little development in the early twentieth century, the Bronte sheet was from the nineteenth century, in this case from 1885. The first edition was printed in December 1941. A Second Edition (Coloured) was published in 1943, using a Kodaline from the War Office for the detail and pulls of the blue and red but revised and printed in Egypt and given the M.D.R. number 578/8152 (Fig. 8). Fryer notes that units in Cairo found that combining the Kodaline with the red and blue pulls created problem, and it was found quicker to redraw the red and blue.[17] The sheet carries a diagram of the area revised from air photos, but apart from the road classifications shows little change from the First Edition. The map is basically a reprint in brown of the First Edition, with the grid also now in brown, but with water features overprinted in blue and roads classified in red. As Clough notes, the Second Edition was originally printed in a grey-blue, rather than brown. In French grey-blue is "gris-bleu" which the British soldiers called "griblet".[18] The sheets were therefore referred to as griblets, even when the printing colour was changed to brown. As will be discussed below, the use of grey-blue for printing the detail on maps was revived when defence over-prints and other tactical information was printed on both 1:50,000 and 1:25,000 sheets. 18 different map sheets were printed for Operation Husky with 20,000 copies of each being made.

For areas of Italy that were covered by 1:25,000 mapping, but not by 1:50,000 maps, A.M.S. undertook to produce 1:50,000 mapping in the United States. The resultant maps were derived from a combination of 1:25,000 and aerial photography if available. The earliest First Edition sheets from 1943 were largely

16 G.S.G.S, 1943, 10.

17 Fryer, 1943, 4.

18 Clough, 1952, 305.

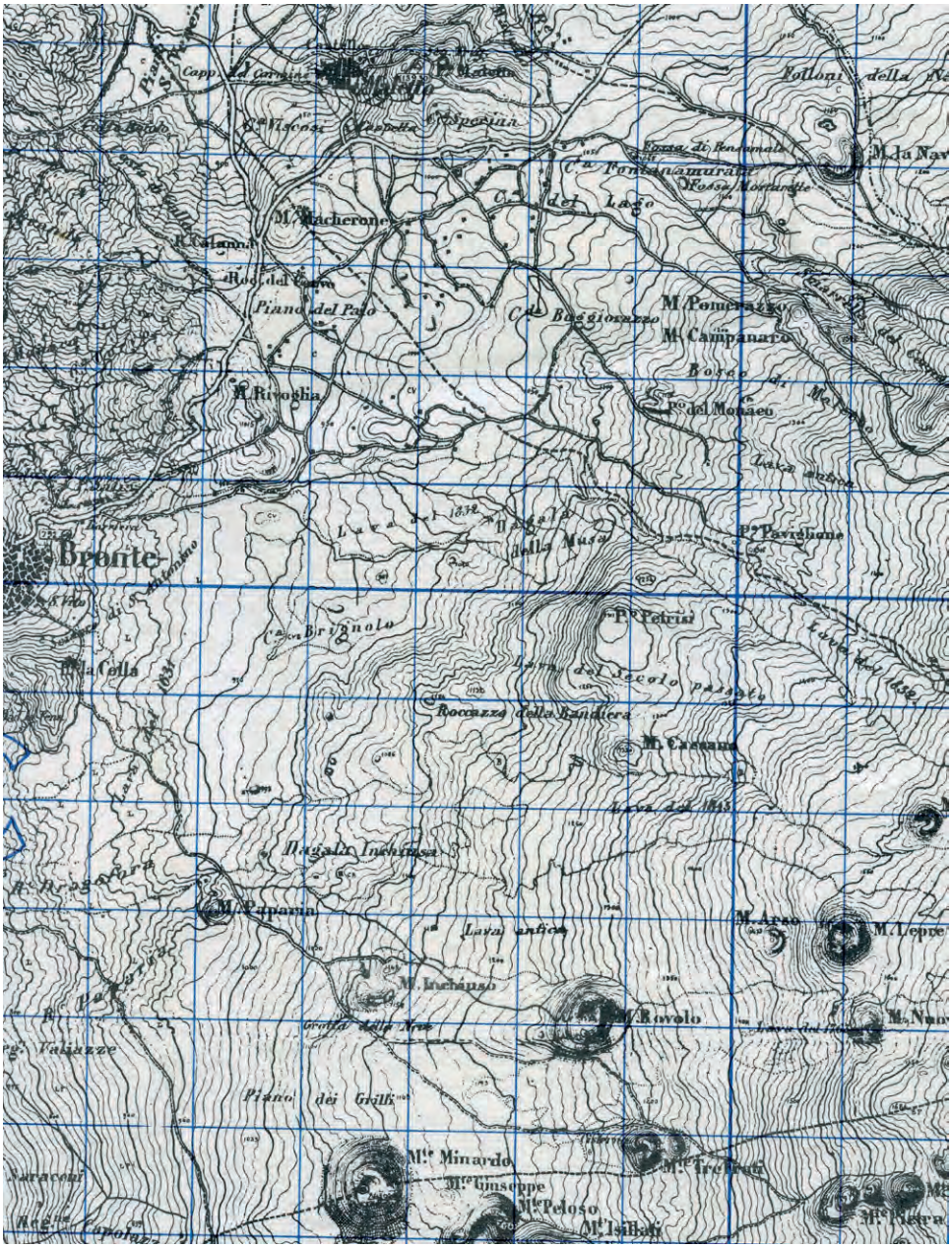

Fig 7 Detail of the 1:50,000 Bronte sheet (261 II) G.S.G.S.4229, First Edition dated 1941 shows the area around Bronte in Sicily. Printed by the War Office in London, this sheet was a direct monochrome copy of the Italian sheet from 1885 with the addition of a blue military grid. (Author's collection)

Fig.8 Detail of the 1:50,000 Bronte sheet (261-II) G.S.G.S. 4229, M.D.R. 578/8152 Second Edition (Coloured) dated May 1943. This map is a brown "griblet" with the water features over-printed in blue and roads in red. The reprographic material for the brown plated was supplied by the War Office, but the red and blue plates were produced in Egypt. (Author's collection)

derived only from existing 1;25,000 maps, with communications updated from Carte d'Italia, del Touring Club Italiano 1:200,000 maps. Later First Editions and Second Editions were often heavily revised from aerial photography. Following American practice, the diagram of the area revised from aerial photography has a note attached giving the sortie numbers and dates of the photography used.

The A.M.S. maps look quite different to the G.S.G.S./M.D.R. sheets as there is a greater use of colour, with vegetation symbols being printed in green. As everything was redrawn the line-work is much cleaner and there is no over-printing of blue on brown line for the drainage. The early First Edition, usually dated 1943, sheets adhere to the original Italian symbolisation for vegetation and the key is essentially the same as on the British sheets, with "Scattered Trees" being shown at three densities, "(Close) (Medium) (Open)". On later First Editions, usually with 1944 dates, the symbolisation for vegetation has been modified to have a much denser symbolisation for woods and only a single symbolisation for "Scattered Trees". Later First Editions also add a new symbol for "Shrine" to those for Church and Chapel on earlier sheets. Early A.M.S. sheets have the note "Heights in Meters" printed in red, but this changes in later sheets to being printed in blue (Fig. 9). Later Second Edition sheets have the symbolisation of vegetation completely changed, and the symbols enclosed in boxes in the Legend. Two new classes of vegetation "Brushwood" and Woods-Brushwood" were added. The symbolisation of urban areas was also changed. Instead of showing urban areas as a network of roads lined by solid black buildings, the urban area is as a network of white lines running through a black half-toned area which is surrounded by a thin black line. The depiction of roads was also changed from parallel black lines with different red fills, to solid black lines of different thicknesses with "A", "1", "2" or "3" in circles to indicate the class of road. The use of solid black for roads meant that the railway symbolisation also needed to be changed to avoid confusion with roads. Symbols for religious buildings also changed from a simple cross for a church to an open circle with a cross, a chapel was changed from a filled square with a cross to a filled circle with a cross and a shrine from a filled circle with a cross to a simple cross. An addition to the symbolisation was the introduction of "Photo Principal Point with Exposure Number". While earlier sheets had included a symbol for cliffs in brown, later sheets also included symbols for "Sink Holes" and "Karst", also in brown, and solid black lines for "Prominent Walls" and black cross-hatched dotted lines for "Areas of Extensive Stone Walls" (Fig. 10).

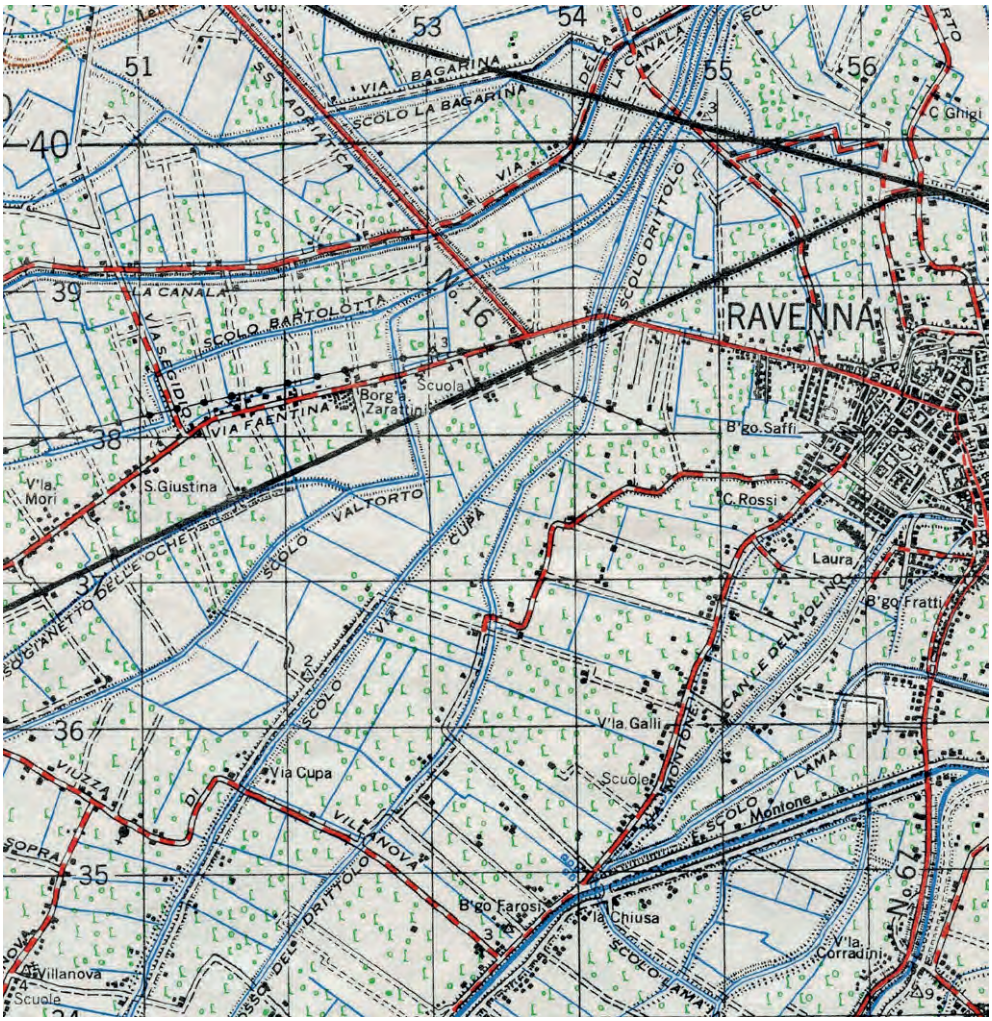

Fig. 9 Detail of the 1:50,000 Ravenna W. sheet (89-III) Second Edition A.M.S. dated 1944. This is an early style A.M.S. Second Edition style sheet with the original vegetation and other symbols but printed in colour. (Author's collection)

Layer tinted versions of some of the 1:50,000 maps were produced as part of "special mapping projects" between 10 July and 15 August 1944 as part of the preparations for the invasion of southern France (Operation Dragoon, originally Operation Anvil).[19] Some layered maps 1:50,000 sheets of Italy were produced at

19 Clough, 1952, 313.

Fig.10 Detail of the 1:50,000 Pesaro sheet (109-I), G.S.G.S. 4229, A.F. 14598, Fourth Edition printed and revised by 13 Corps. Field Survey Company Royal Engineers in July 1944, but using reprographic material produced in 1943 by A.M.S. The brown and blue plates shows the improved quality of the American drawn maps despite being printed in "griblet" form. (Author's collection)

the same time. Figure 11 is an extract from Sheet 99-III Marradi, reproduced by 514 Corps Field Survey Company in July 1944. It carries the A.F. number 14829. The base map is that for an early Second Edition A.M.S. map. In addition to the layer tints, the sheet also has "FOR STAFF USE ONLY NOT AVAILABLE FOR

GENERAL ISSUE (LAYERED)" to the right of the sheet name. To the left of the name is "NOT TO BE USED FOR ARTILLERY FIXATION". Both notes are printed in brown. Marradi was in part of the German Gothic Line, which may account for the production of the layered map.

Special 1:50,000 "griblet" maps were produced for the planned invasion of southern Italy from Sicily. The griblets were then over-printed in violet to show military installations, and red for topographical and beach information. Text in red describes the topography, such as "moderate slopes" and "Frequent landslides". Violet is also used to show the beach limits, with each beach numbered. Area limits and names are in red where appropriate there are also notes in red giving the normal port capacity of the ports (see Fig. 12). The sheets carry their normal G.S.G.S. number but also and A.F. number in violet, together with defence overprint date. There are two air photo cover diagrams, the normal Second Edition one in grey-blue and an addition one in violet with a note stating that the air photos were interpreted by N.A.C.I.U. (North Africa Central Interpretation Unit) and "Defences positioned by 516 Corps Fd. Svy. Coy. R.E. from annotated photos." "Intelligence collated by G-2. A.F.H.Q.". As will be seen in the section on 1:25,000 scale mapping, The griblets with defence overprint performed the same role as the 1:25,000 "Naval Collation Maps" produced for the invasion of Sicily. Similar "First Collation Edition" sheets with coastal and topographic information over-printed in red and beach exits and defences in violet were prepared in anticipation of possible amphibious operations further north in Italy, such as around Rimini. Collation editions of non-coastal areas, or coastal areas where no amphibious operations were anticipate (in other theatres the term collation edition was limited to areas of proposed amphibious operations), tended to have less information over-printed on them. If no defences had been interpreted from aerial photography the map would just have a red over-print together with a note "There are no defences on this sheet". Grid line numbers in red were also overprinted on the body of the map to allow easier reading of coordinates. Most Collation over-prints seem to have been printed on Second Edition griblets, but some on Third Edition and Second Edition A.M.S. griblets are also found. Bridge information includes the construction material, bridge length and roadway width in feet. Thus the Ponte Vecchio in Firenze is annotated "3 span Masonry Buildings on bridge OAL 345', Roadway 20'," (Sheet 106-II, Firenze).

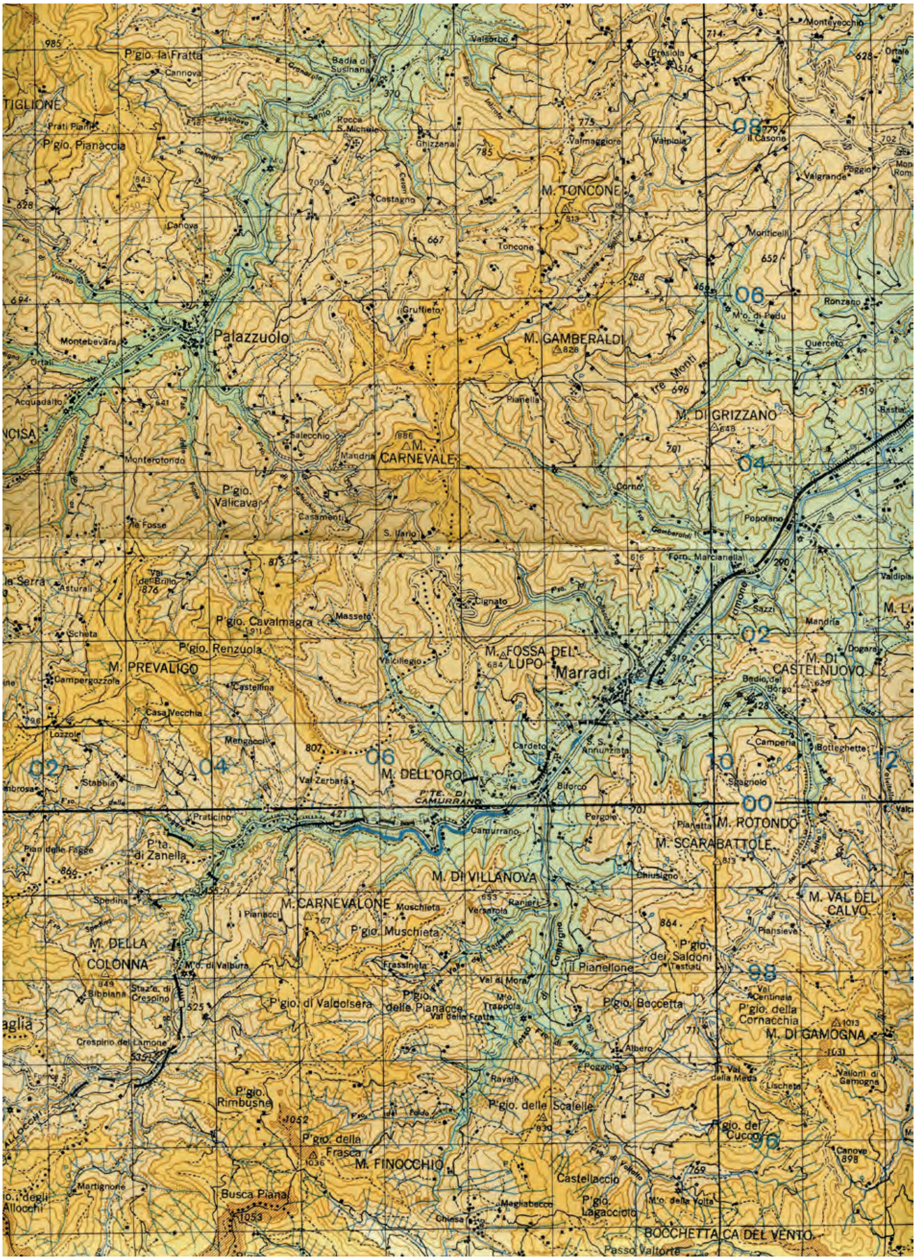

Fig. 11 Detail of the 1:50,000 Marradi sheet (99-III) G.S.G.S. 4229, .A.F. 14829 Second Edition (Layered). This is an example of a Second Edition A.M.S. map, dated 1944, that has had layer tints applied in theatre, hence the A.F. numbering. These layered maps were only for staff use and not issued to troops in the field. (Author's collection)

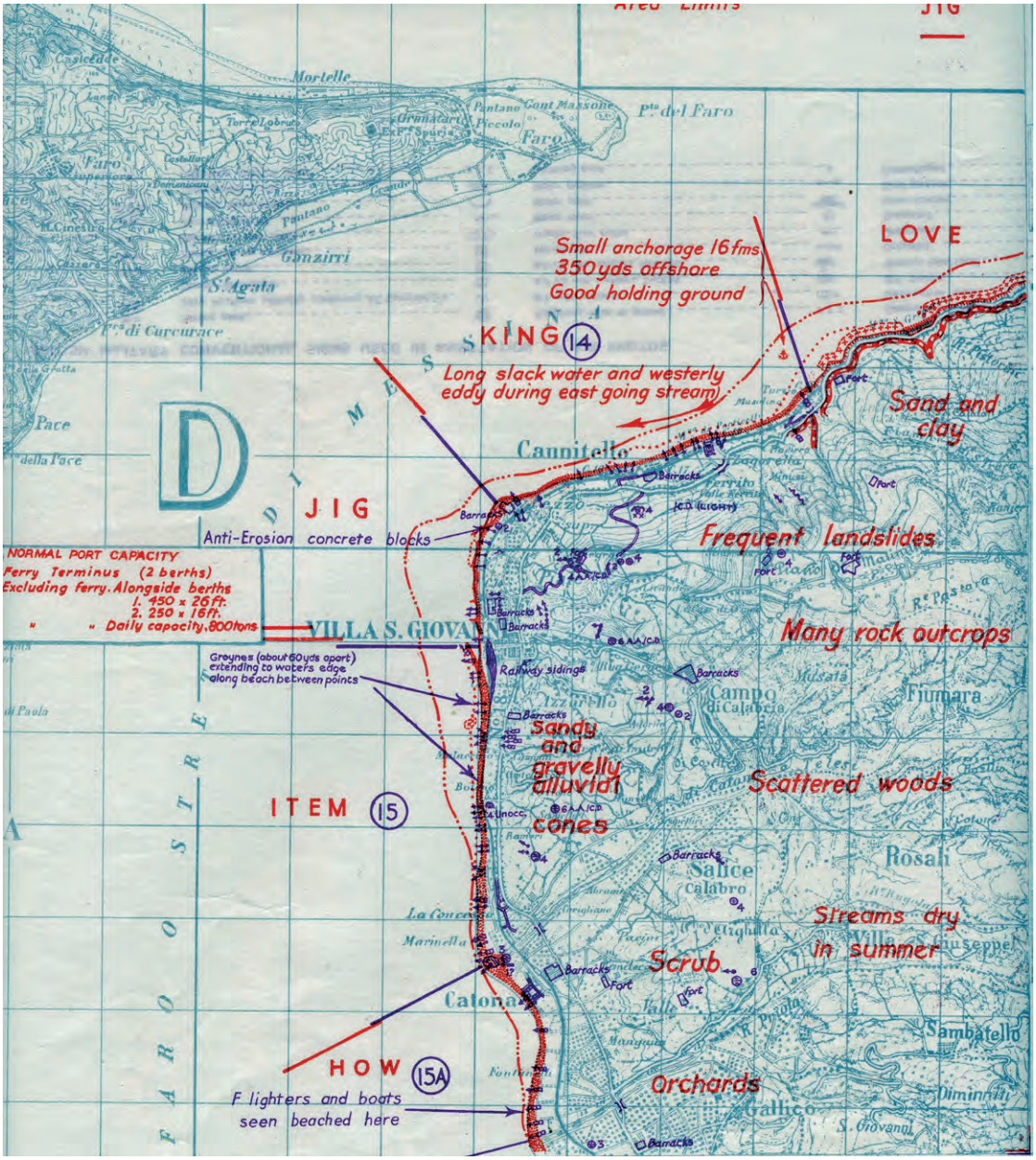

Fig.12 Detail of the 1:50,000 Messina sheet (254-IV) G.S.G.S. 4229, A.F. 1508 Second Edition (Coloured) but printed as a grey-blue "griblet". This is a typical example of the 1:50,000 sheets, date I July 1943, over-printed in violet for defences and red for coastal information and descriptions of topography. (Author's collection)

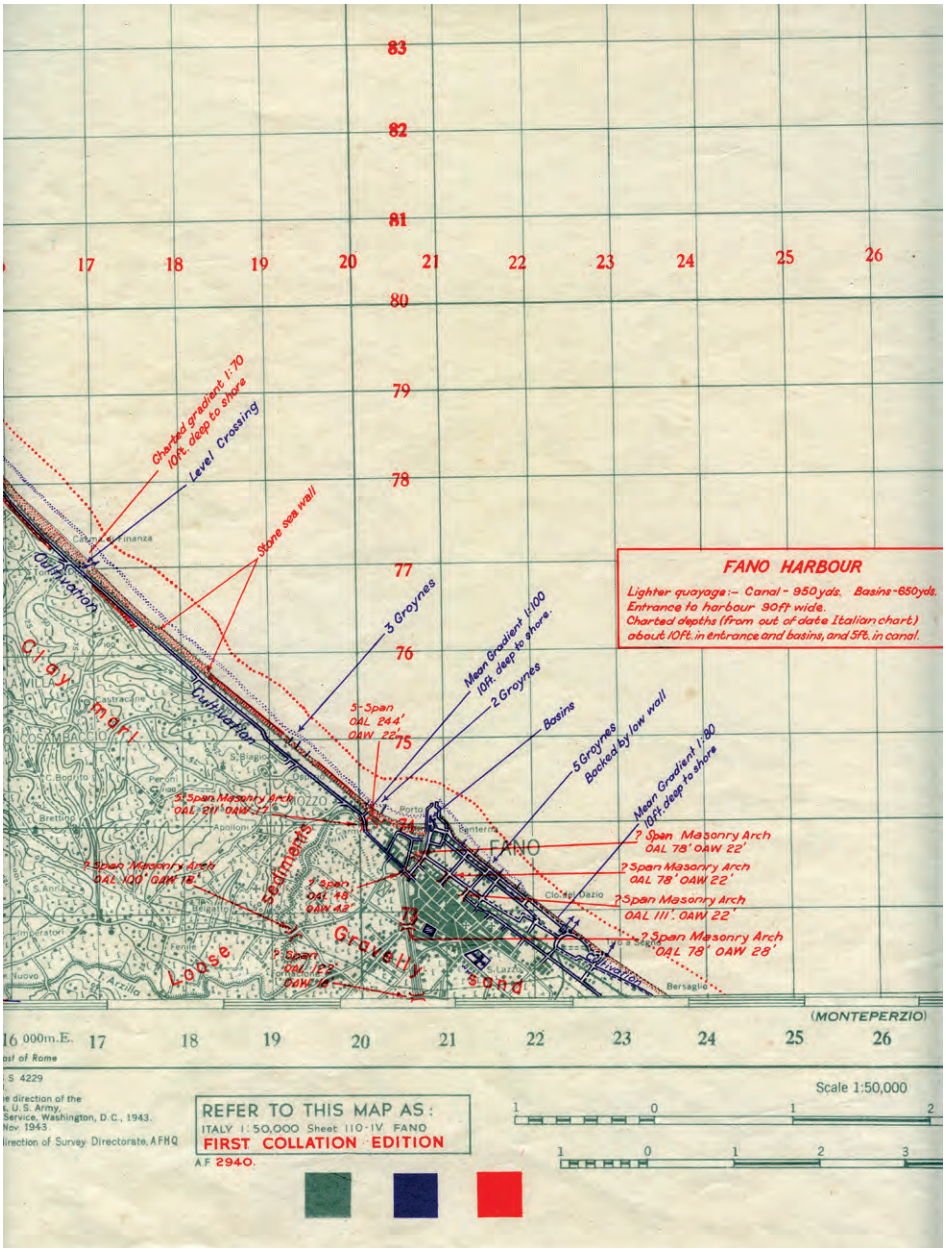

Fig 13 Detail of the 1:50,000 Fano sheet (110-IV) G.S.G.S. 4229, A.F. 2940 First Collation Edition March 1944. This map uses as a base map the A.M.S. Second Edition from 1943 printed as a "griblet" with beach defences and obstructions over-printed in violet and bridge and topographic information over-printed in red.

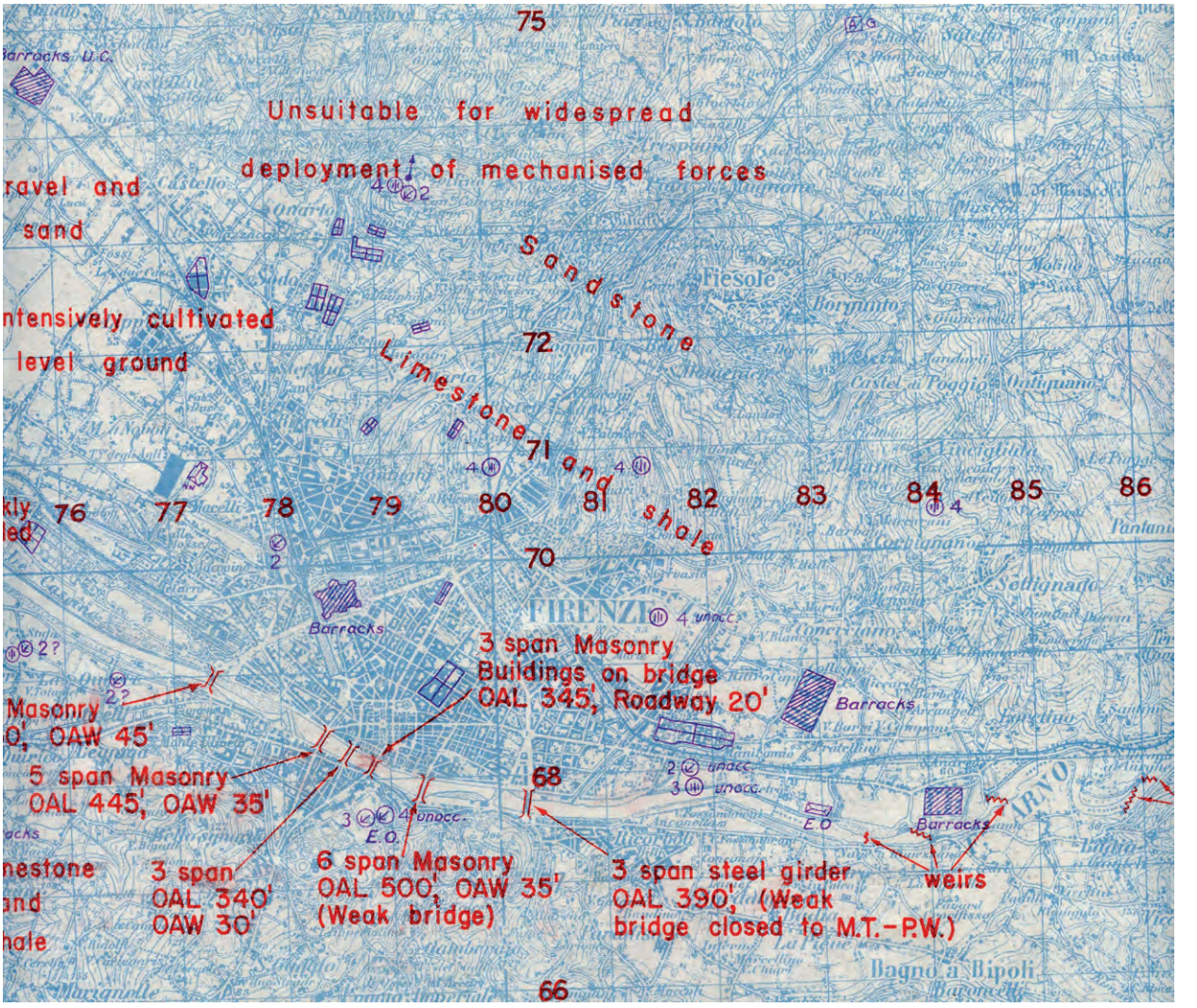

Fig.14 Detail of the 1:50,000 Firenze sheet ((106-II) G.S.G.S. 4229, A.F. 2871 First Collation Edition November 1943, has topographic and defence information over-printed on a "griblet" of a British produced Second Edition sheet. Classified as Secret, it was not down-graded until 10 May 1945. (Author's collection)

1:25,000 Scale Mapping

After the First World War a review of future mapping needs for the British Army identified 1:25,000 as the ideal scale for tactical operations and, in particular, for artillery targeting.[20] Malcolm MacLeod, the Director General of the Ordnance Survey and former Director of Military Surveys in the War Office, realising that a future war in Europe would necessitate British forces using metric maps was keen for Britain to adopt metric scales. Following the Davidson Committee report on the future of the Ordnance Survey, a new map of Britain at 1:25,000 was initiated, although a 1:50,000 map for army training purposes was rejected. The 1:25,000 scale map was referred to as the $2^1/_2$ inches to one mile scale possibly to disguise its metric nature. The use of 1:25,000 scale maps was therefore something that British forces were already becoming used to when war broke out.

The 1:25,000 allied military mapping of Italy was amongst the most complex tasks the surveyors had to undertake. The number of sheets, the number of editions of individual sheets and the variety of overprints presented a major challenge that could not have been met by British surveyors working on their own. In common with the 1:50,000 map sheets, the first editions were monochrome with colour being introduced to emphasise communications and water features on the second and subsequent editions. Initially, 1:50,000 maps were enlarged for areas not covered by Italian 1:25,000 maps. Effectively, this meant for areas to the south of the Lombard plain with the exception of areas around Roma and Napoli on the mainland and much of northern Sicily. Production of new 1:25,000 map sheets started in the spring and early summer of 1944 aided by better access to aerial photography for those areas previously covered by the enlarged 1:50,000 maps[21]. Prior to Operation Husky 67 map sheets were printed in runs of 10,000 copies by AFHQ and 57 map sheets were printed by SDMEF in runs of 8,000, a total of 1,260,000 map sheets.

The first 1:25,000 to be produced were for the invasion of Sicily and comprise approximately 200 standard map sheets plus 18 special map sheets covering the coast from Catania to Licata. Each of the 18 special map sheets covered the

20 Peter Collier, « The work of the British Government's Air Survey Committee and its impact on mapping in the Second World War », *Photogrammetric Record* 21/114 (2006), pp. 100–109.

21 Clough, 1952, p.311.

area of three standard sheets being printed double demy format (572x902 mm or 22.5x35 inches). While this made for quite unwieldy map sheets, it saved on printing time for the 18,000 copies of each needed[22]. The most important of these 1:25,000 sheets were those overprinted with additional information the "Naval Collation Maps" as they were overprint with information vital to the invasion forces. Whereas the standard sheets had "NOT TO BE PUBLISHED" printed at the top in brown, the Naval Collation Maps had that note crossed out and "SECRET" print in a larger font. The Naval Collation Maps had two overprints, a green overprint that showed topographical information which had been collated by G.S.I. and an overprint in blue which showed defences, beach information, ports, aerodromes and industry. A boxed note in blue at the bottom of each sheet stated "Information in BLUE is from Air Photography only, has been plotted from detail by A.A.P.I.U and not surveyed in. For conventional signs see A.A.P.I.U. legend. Defences and Beach Interpretation in BLUE by A.A.P.I.U. Ports, Aerodromes and Industrial Interpretation in BLUE by M.E.I.U". Four editions of these maps were produced, the First by 1 May and the Fourth by 1 July to ensure that the defence information was as up-to-date as possible before the invasion on 9 July.

Mapping in preparation for the invasion of the Italian mainland was limited to the revision of the 1:50,000 topographic sheets and the overprinting noted above. The short timescale between the invasion of Sicily and the landings on the mainland were the probable reason why no 1:25,000 mapping was produced for the landings, although Clough makes no reference to the reason. 1:25,000 mapping with overprinting of information for amphibious operations was produced for anticipated or planned operations further north in Italy. This included the mapping Elba in preparation for the assault by Free French and British forces. A bi-lingual edition of the maps was prepared with the maps overprinted with TOP SECRET – ULTRA SECRET and all annotations and legends in both French and English. The style of the overprinted maps is similar to that of the 1:50,000 maps discussed above but with colour changes. The 1:25,000 topographic sheet was printed as a grey griblet, with information derived from aerial photography was overprinted in red and information derived from other sources was overprinted in violet. The map sheets for the invasion of Elba were each individually numbered with "Copy

22 Fryer, 1943, p.5.

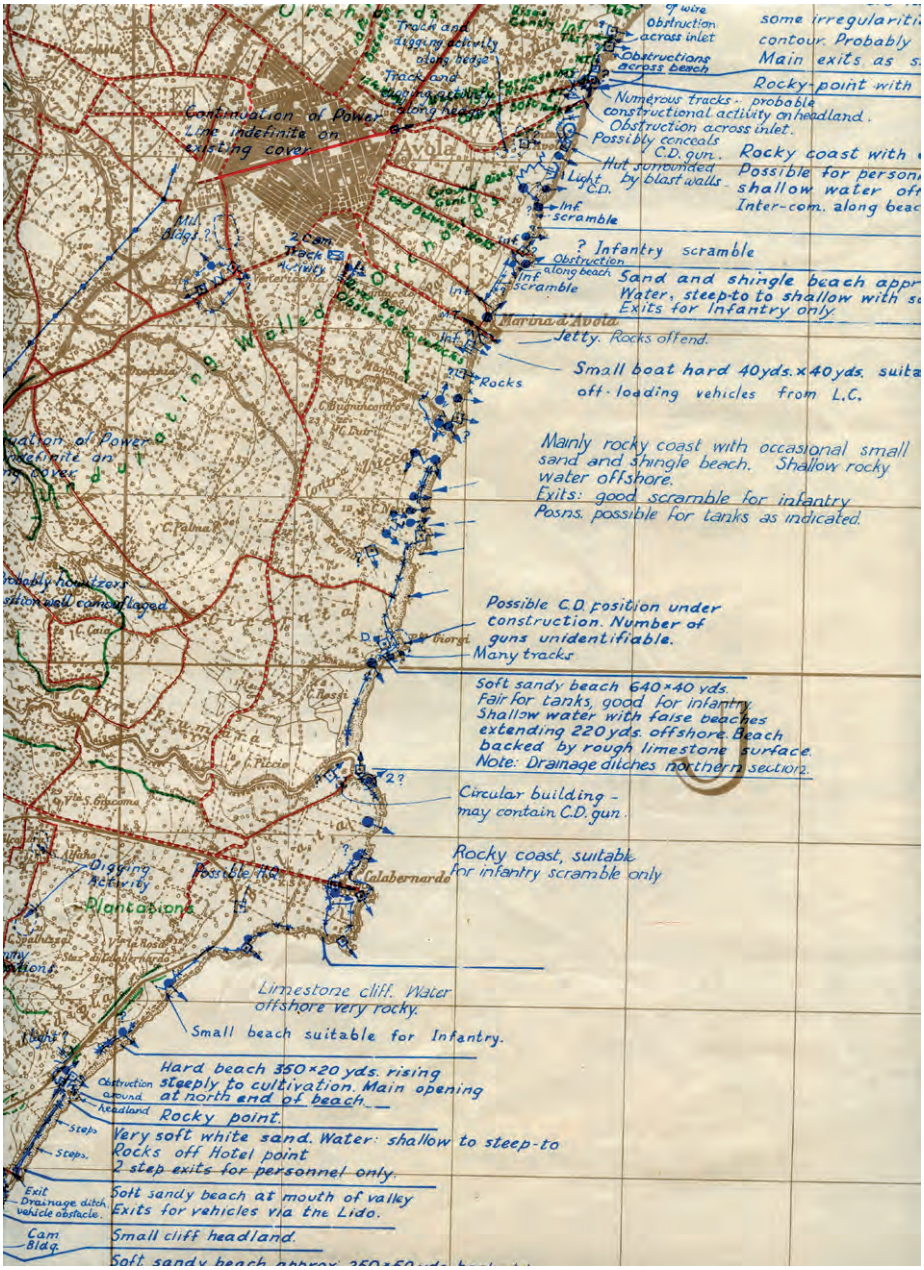

Fig. 15 Detail of the 1:25,000 Avola sheet (10), M.D.R. 618/8857 dated 17 June 1943 Edition III. This is an example to one of the double demy maps produced for Operation Husky. A brown "griblet" was over-printed in blue for defences and beach conditions and in green for topographical features and road widths. (Author's collection)

On opposite page: Fig. 16 Detail of the 1:25,000 Capoliveri sheet (126 II S.E.) G.S.G.S. 4228, A.F. 3909. This over-printed map printed on a Second Edition "griblet" base published by the War Office in 1943 had a defence over-print added on 20 April 1944 in preparation for the Free French Army assault on Elba. Unusually, there is bilingual text on the face of the map in addition to a bilingual legend on the verso of the sheet. All copies of the map were individually numbered, a system that had been adopted for "Top Secret" mapping for Operation Overlord but does not seem to have been adopted for other mapping in the Italian campaign. (Author's collection)

Nº" in violet followed by a number in black. The numbering of individual copies of a sheet had not been the practice for earlier mapping in Italy but was normal practice on similar maps produced for the invasion of Normandy. The Elba map sheets were not the only ones to have multilingual legends, although they seem to have been the only examples that had bi-lingual annotations and notes on the body of the maps. Bi-lingual legends in English and Polish were printed on maps prepared for the fighting around Monte Cassino in 1944 and tri-lingual editions were prepared with legends in English, Polish and Italian in preparation for operations in Lombardy in spring 1945.

The need for new editions of 1:25,000 maps became urgent when the allied armies' advance was blocked by the German Gustav Line which stretched from the mouth of the River Sangro on the eastern side of the Apennines to just north of where the River Garigliano entered the Tyrrhenian Sea. To meet the urgent need for 1:25,000 for artillery use rapidly product skeleton maps, called "key" maps were produced in addition to new 1:25,000 maps of areas in front to the allied positions[23]. New editions with defence overprints in red were produced on 10 and 28 April 1944 and "Artillery Tasks" overprints were produced on the 28 April defences sheets in May 1944. The artillery task sheets showed both areas to be subjected to barrages (Fig. 17) and also point targets in violet (Fig. 18)

With the fall of the Gothic Line and the allied advance to the Po Valley little detailed mapping was needed on the scale of that for the fighting around Cassino until the winter of 1944-45. During the spring of 1945 extensive mapping of the Po Valley and the approaches to the Alps was carried out. The conditions in the

23 Clough, 1952, p. 310.


TERRACED
Isolotto dei Liscoli
P. di Buzzancone
Punta nera
08
BARE SLOPES
PENTES NUES
O.P.
4×152 m.m. (P.A.)
R.S.
M. Calamita
2×152 m.m.
Spiaggia
THIN SCRUB ON BARE ROCK
MAQUIS EPARS SUR PENTES ROCHEUSES
HARD ROCK – THIN SOIL
ROCHERS DUR – SOL PEU PROFOND
O.P.
4×152 m.m. P.A.
2(? D.P.)
Cam
DENSE SCRUB
MAQUIS EPAIS
Gemini
P. del Praticciolo
Cava della Calamita
4 P.A.
P. Rossa
P. della Calamita
4Lt./Med.
Scoglio di Remaiolo
62
P. di Vallemorta
P. dei Ripalti
Dinghy landing
Débarquement pour
bateaux en caoutchouc
Quarry loading jetty
Jetée de chargement
pour carrière
1:22 from 18 ft.(deep) to shore.
61
03
04
05
06
07
60
59
INCLINAISON DES PLAGES.
"1:44-10 FEET (DEEP) TO SHORE" SIGNIFIE QUE LA PENTE MOYENNE, DU BORD DE L'EAU A UN POINT SITUE A LA PROFONDEUR DE 3 METRES 05 AU-DESSOUS DU NIVEAU

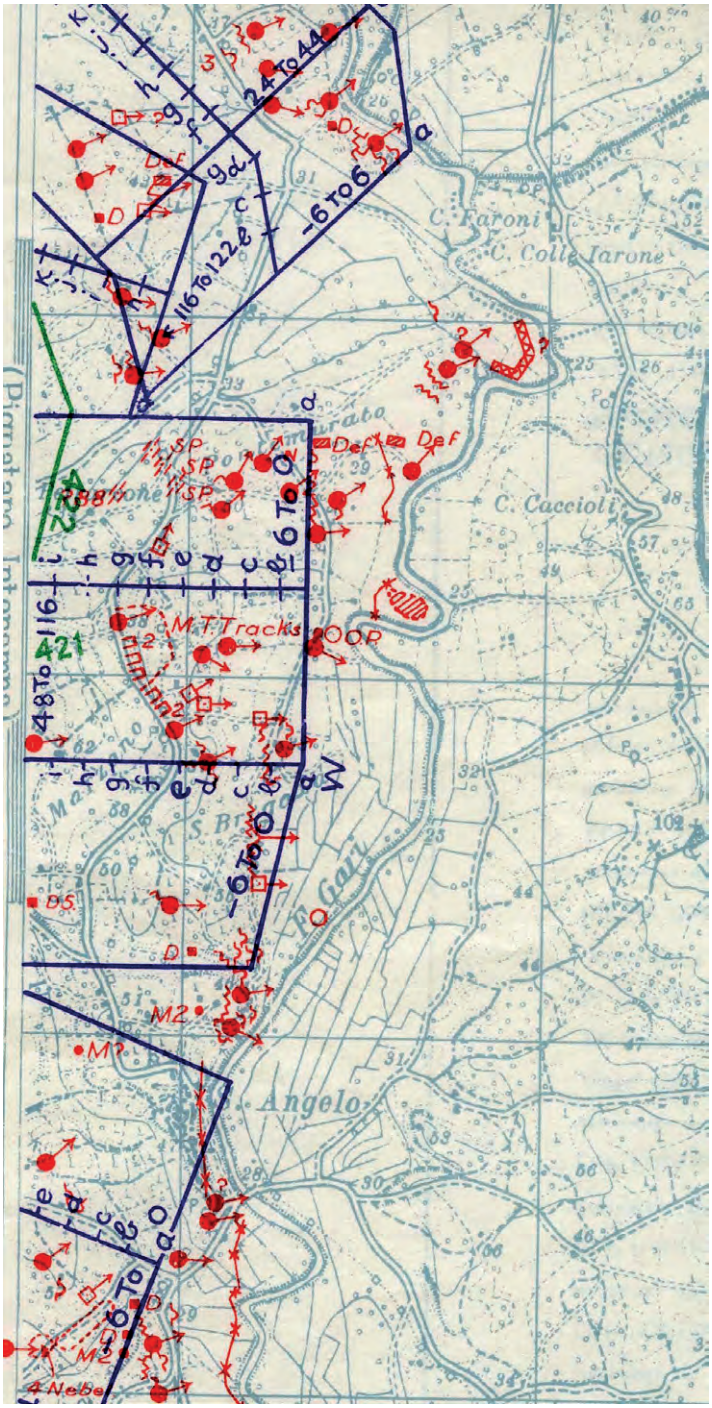

Fig. 17 Detail of the 1:25,000 Cassino sheet (160. II. N.E.) G.S.G.S. 4228 First Edition 1943 published by Engineer Fifth U.S. Army A.F.14587. This sheet has a similar publication and over-printing history to Fig. 18 but it carries an additional note "All timings are from the time of inf." (infantry) "launch boats" as this map shows the areas to be targeted by moving barrages rather than the point targeting on Fig. 18. (Author's collection)

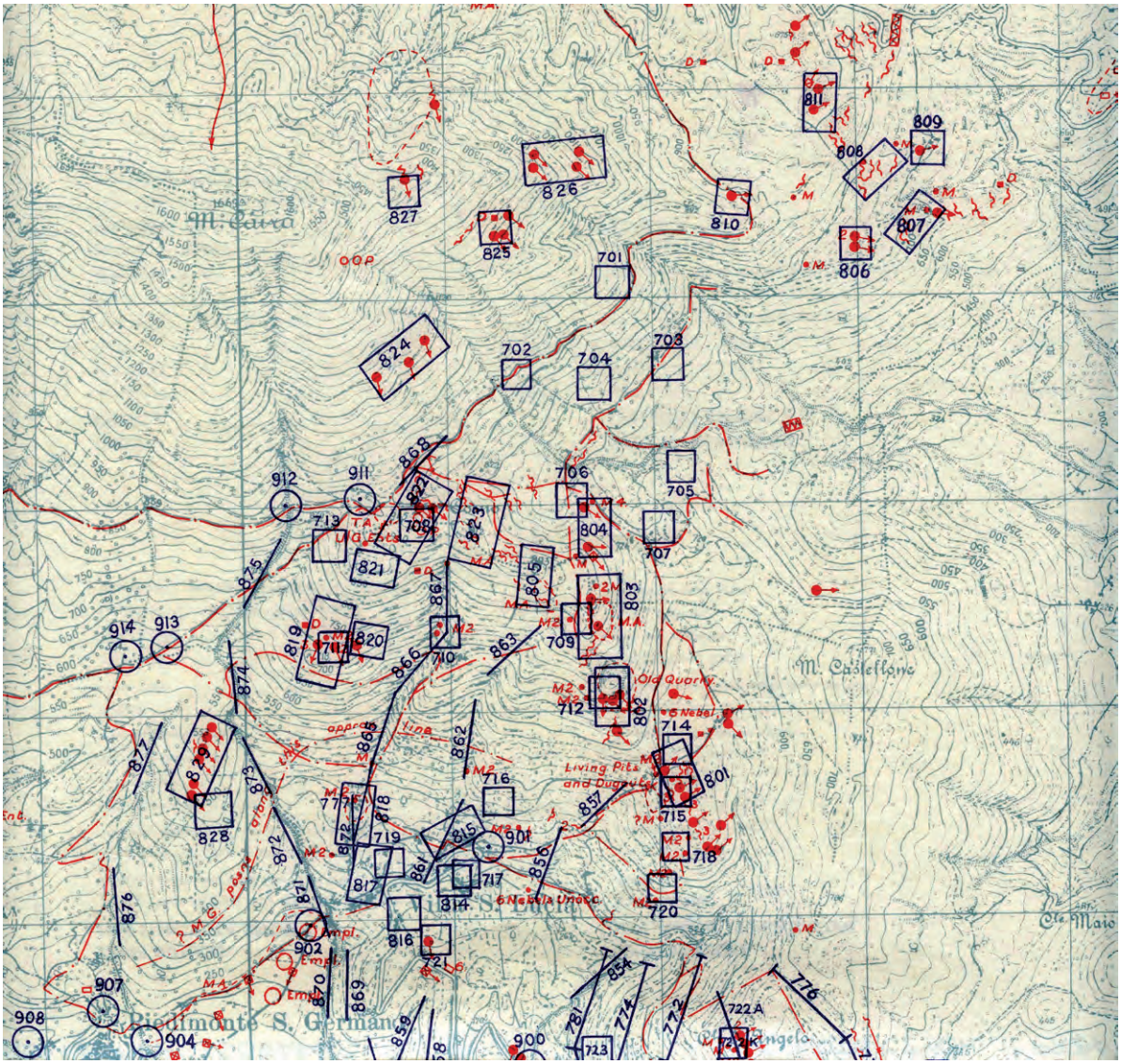

Fig. 18 Detail of the 1:25,000 Terelle sheet (160. I. S.W) G.S.G.S. 4228, A.F. 14570 was published by Engineer, Fifth Army, reproduced from an Italian map by 46 Survey Company South African Engineer Corps in January 1944, defences were added as a red over-print from aerial photography "up to and including" 28 April 1944, and "Artillery Tasks" as a violet over-print in May 1944 by 514 Corps Field Survey Company Royal Engineers. The map was intended to be used in the fighting around Cassino by allied forces including Polish soldiers. The verso carried a bilingual legend in English and Polish. (Author's collection)

Fig. 19 Detail of the Minerbio sheet (88 IV N.W.) G.S.G.S 4228 Third Edition, A.F. 15681. The brown "griblet" base is derived from a revision by the South African Survey Company, with the topographical overprint added in April 1945 by the same unit. (Author's collection)

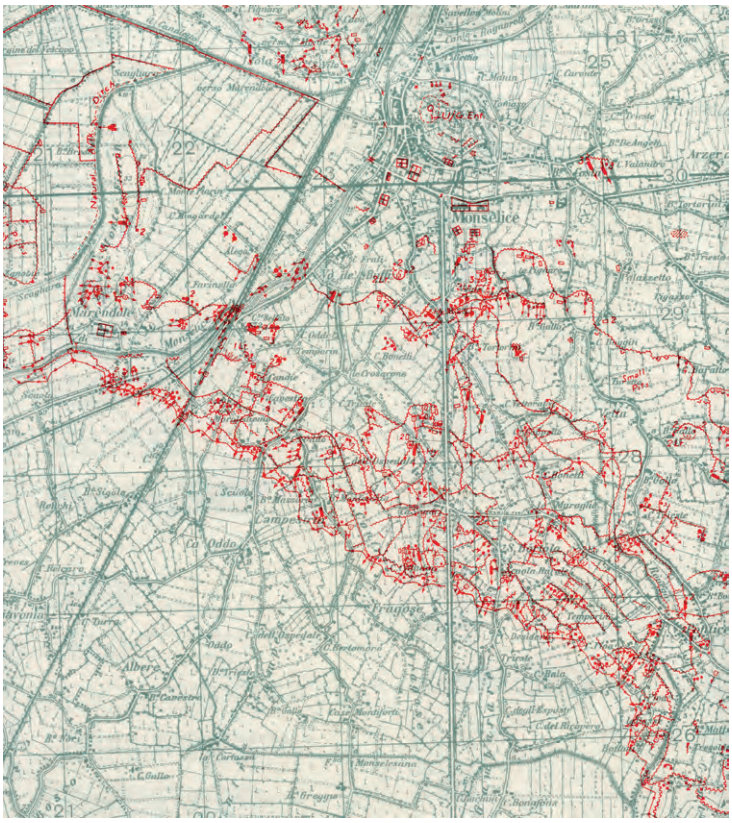

Fig. 20 Detail of the Monselice sheet (64 I S.W.) G.S.G.S. 4228 War Office Second Edition 1944, revised June 1944 by 19 Field Survey Company Royal Engineers, minor corrections March 1945 by 49 Survey Company South African Engineer Corps, over-print drawn by 7 General Field Survey Section Royal Engineers, printed on 26 April 1945 by 518 Field Survey Company Royal Engineers. (Author's collection)

Po Valley itself called for detailed topographical over-prints, accompanied by cross-sections of features likely to limit mobility. Fig. 19 is a good example of such a sheet with the different blue lines indication the width of canal and river channels. The cross-sections show the form of the canals and rivers at particular points. Bridge lengths are also marked on the map.

As the allied armies crossed the Po Valley and approach the mountains to the north, heavy fighting was still expected despite a German surrender was already being negotiated. Some of the last maps to be printed with defence overprints were produced towards the end of April 1945. Fig 20 is the area around Monselice south of Padua. The over-printing was carried out on 26 April 1945 showing a section of the German Venetian Line behind the River Adige. As British, Polish and Italian soldiers were taking part in the advance across the Po Valley, map sheets were printed with trilingual legends.

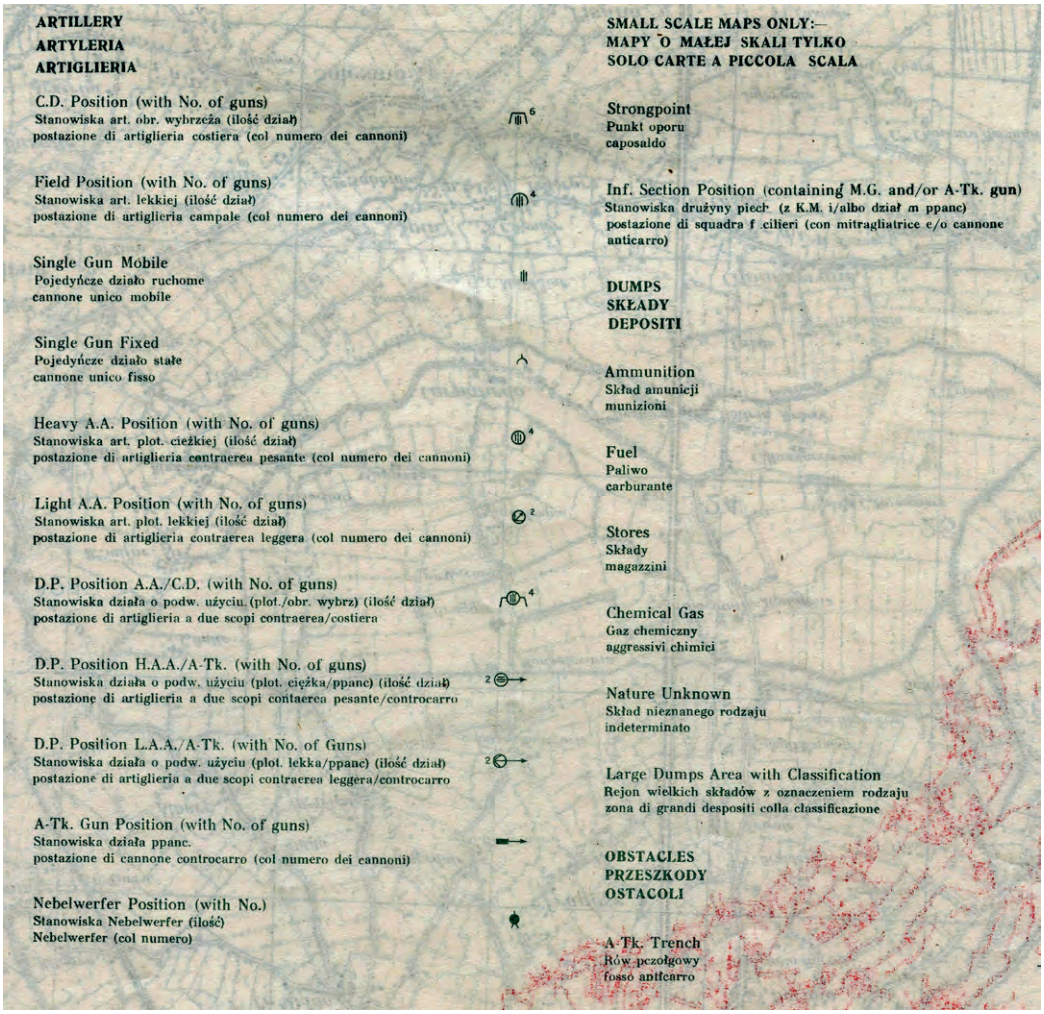

Fig. 21 Verso of Fig. 20 showing part of the trilingual legend. (Author's collection)

Town Plans

Prior to the invasion of Italy near 22 town plans had been prepared for Sicily as G.S.G.S. 4379, 44 for the Italian mainland (but including plans of Pola and Fiume and Susak) as G.S.G.S.4380, two of Sardinia as G.S.G.S 4378 and four f Sardinia as G.S.G.S. 4381. Initially, most of the town plans were simple enlargements to 1:10,000 of 1:25,000 mapping printed in black, except for water features which were in blue, except where Italian town plans were available to the War

Office. Some plans, such as Napoli had been revised from aerial photography and redrawn and other plans, such as Genoa, were in the process of revision[24]. These sheets were published as the second edition, but some plans, such as Napoli quickly went to a third edition in 1943Work on the compilation or revision of some of the town plans was carried out by the Inter-Service Topographical Department (I.S.T.D.). An example is the "Sicily Small Ports" sheet. In this case, the source material the plans of Sciacca, Mazara del Vallo and Porto di Favignana was Italian charts with revision from aerial photography. The plan of Riposto on the same sheet was compiled from "uncorrected" aerial photography (Fig 22). As was the case with other smaller towns, two of these plans were at 1:5,000, but Sciacca was at approximately 1:5,200 and Riposto was at approximately 1:10,300. The revision of the plans enlarged from 1:25,000 involved the identification of important buildings in black where the enlarged map was shown in grey, with water features in blue. While the unrevised enlargements from 1:25,000 maps were printed in black and blue, some maps, usually derived from tour guides, petrol company maps or maps from the Reale Automobile Club d'Italia (R.A.C.I.), were printed in grey. An example is the provision edition for Mantova which had a 1:15,000 plan derived from a tour guide and a "Through Roads" plan copied from the R.A.C.I. map. Where the scale of the map did not allow the labelling on the map of important buildings, roads, etc. a list of names was appended to the sheet, for example the Tivoli provisional edition from 1943.

A more unusual example is the First Edition plan of Salerno. The plan at approximately 1:5,070 was compiled and drawn from aerial photography by the Central Interpretation Unit (C.I.U.) and checked by I.S.T.D., and printed by the War Office (Fig. 23) For some reason, there is also an inset plan at 1:10,000 covering the same area, together with an index of place names and buildings. However, in addition to the C.I.U. plan which was printed in September 1943, there was also a "Plan Mosaic of Salerno" at approximately 1:10,000 prepared by the 649th Engineer Battalion, U.S. Army, an uncontrolled mosaic produced in July and printed in August 1943 as AF 1756 (Fig. 24). As the AF designation on the photo-mosaic indicates, the 649th Engineer Battalion was attached to A.F.H.Q. in North Africa. It is probable that the photo-mosaic was prepared from the same material as the C.I.U. plan either because the U.S. forces wanted a photo-mosaic

24 G.S.G.S, 1943, p. 14 contains a full list and samples of the types of plans available.

Fig. 22 Plan of Riposto from the "Sicily Small Ports" sheet G.S.G.S. 4379 First Edition, War Office 1943 (Author's collection)

Fig. 23 Detail of the 1:5070 approx. plan of Salerno G.S.G.S. 4380 First Edition, War Office 1943(Author's collection)

Fig. 24 Detail of 1:10,000 (Approx.) Town Plan Mosaic of Salerno AF 1756 August 1943. (Author's collection)

for the reasons outlined below, or as insurance in case a conventional plan was not available in time for the invasion of the Italian mainland.

Production of improved town plans continued throughout the campaign with the cartographic and printing resources of the Istituto Geografico Miliare (I.G.M.)

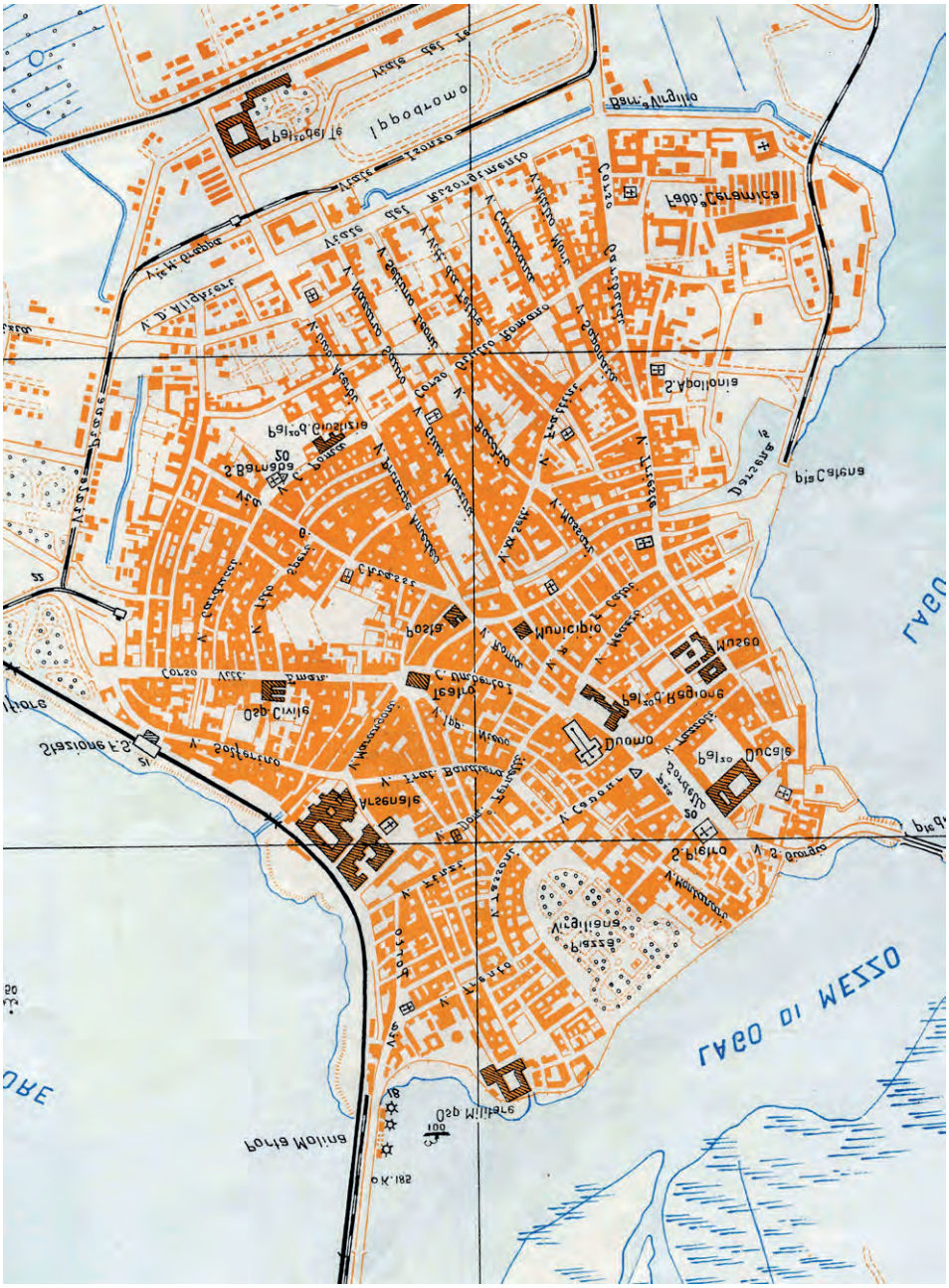

Fig. 25 Detail of 1:10,000 Town Plan of Mantova G.S.G.S. 4380 A.F. 18591,
First Edition 1945. Drawn and reproduced by Istituto Geografico Militare April-1945.
(Author's collection)

Fig.26 Verso of Fig.25, detail of Photomap of Villanova produced for the Italian occupation of Corsica. (Author's collection)

in Firenze being drawn upon. At that time the resources of the I.G.M. were being drawn upon by the Survey Branch H.G. 15 Army Group to supplement their own resources. At this time, the earlier plan of Mantova was replaced by a 1:10,000 First Edition based on the Italian 1:25,000 map and large scale aerial photographs taken between September 1943 and January 1944. What makes the Mantova plans (Fig.25), and similar ones of Cremona, interesting is that they were printed on the reverse of Italian photomaps of Corsica printed in 1943 (Fig. 26). Printing of new maps on the back of redundant map sheets was a common practice during the war. Most commonly the printing took place on the back of old or no longer needed maps previously printed by the forces printing the new maps. Following the capture of bulk map stocks during the Allied advance in North-West Europe, new maps were frequently printed on the back of old German maps, but the Mantova and Cremona plans are a rare example of the same happening on Italian maps.

Mapping and Revision from Aerial Photography

Aerial photography for mapping had become important during the First World War, both for original surveys of previously poorly or unmapped areas and for the revision of existing mapping[25]. In Britain, with the foundation of the Royal Air Force (RAF) by the merging of the Royal Flying Corps and the Naval Air Service, the air force moved away from being seen as supporting the other forces into an independent organisation which set its own priorities. These priorities centred on air defence, and strategic and tactical bombing. Aerial photography came to be seen a tool for the acquisition of targets for the bombers. A Photo Reconnaissance Unit (P.R.U.) was established to analyse the air photos acquired by photo reconnaissance aircraft and cameras were developed to be carried in those

25 See, for example, Peter Collier, « Innovative Military Mapping using Aerial Photography in the First World War: Sinai, Palestine and Mesopotamia », *Cartographic Journal,* 31 (1994), pp 100–04; Peter Collier and Rob Inkpen, « Mapping Palestine and Mesopotamia in the First World War », *Cartographic Journal* 38 (2001), pp. 143–154; Peter Collier, « The Impact on Topographic Mapping of Developments in Land and Air Survey: 1900-1939 », *Cartography and Geographic Information Science* 29/3(2002), pp. 155–174; Peter Collier, « The development of photogrammetry in World War 1 », *International Journal of Cartography* 4/3(2018), pp. 285–295 and Thomas Withington, « Military Mapping by Major Powers: United States », in Mark Monmonier (ed.), *The History of Cartography Volume Six: Cartography in the Twentieth Century,* University of Chicago Press, Chicago, 2015, pp. 884–893.

aircraft. Whether those cameras could take air photos suitable for mapping was not seen as issue by the RAF and it was only with reluctance that they became involved in aerial photography for the Ordnance Survey in the late 1930[26]. Work by the Air Survey Committee, which had been established after the First World War to develop photogrammetry, primarily to meet the needs of the army, had demonstrated the type of cameras that were best suited for air survey work[27]. The very long focal length cameras prioritised by the RAF were found to be unsuitable due to their very limited field of view. What was needed were normal angle cameras with a focal length of c.305mm (12 inches), or wide angle cameras with a focal length of c.152mm (6 inches). What was also needed was a large format negative, typically 230x230mm (9x9 inches), whereas photographic reconnaissance cameras typically employed smaller format negatives[28].

An addition problem in the Mediterranean theatre was the lack of suitable aircraft to carry out sorties of survey photography. The main air photo reconnaissance (PR) aircraft operating with the R.A.F. was the PR version of the Spitfire. While the Spitfire was the best PR aircraft for its chosen task, being fast, manoeuvrable and with a high ceiling, giving the pilot the best chance of surviving and successfully returning with the required air photos. In the first years of the war the only aircrafts available for air survey photography in the Mediterranean were twin engine bombers, the British Bristol Blenheim, and the American Martin Maryland and Baltimore.

While these were able to serve with reasonable success over North Africa, from 1942 on they were far less likely to survive in European air space where the air defences were more highly organised and effective[29]. The arrival of American forces in North Africa following Operation Torch led to the introduction of American PR aircraft, the PR version of the Lockheed P-38, the F-4. Versions of this single seat aircraft were to remain the mainstay of United State Army Air Force

26 For an account of the problems see Peter Collier and Rob Inkpen, « Photogrammetry in the Ordnance Survey from Close to MacLeod », *Photogrammetric Record* 18/103 (2003), pp. 224–243.

27 See Collier, 2006 for a discussion of the work of the Air Survey Committee.

28 Roy M. Stanley, *World War II Photo Intelligence,* Sidgwick and Jackson, London, 1981, pp. 133–186, provides a comprehensive overview of the development of cameras by the United States and Great Britain.

29 Stanley, 1981, p. 107, provides a brief account of these aircrafts and their performance characteristics.

PR work for the rest of the war. Unfortunately, the F-4 suffered from much the same limitations as the Spitfire when it came to air survey work. What was needed was a fast twin engine aircraft which had a crew of two and a fuselage capable of holding a number of cameras and even spare film magazines. Such an aircraft existed, the De Havilland Mosquito. It had been designed for the PR role and could fly higher and out run any likely enemy aircraft. Unfortunately, the R.A.F. regarded it as a PR aircraft and were extremely reluctant to release its Mosquitos for air survey photography.

In the latter stages of the North African campaign air survey photography for British Commonwealth Forces had been provided by No. 60 Squadron South African Air Force (SAAF) which had been deployed to Egypt in July 1941. In January 1942 in had started to carry out air survey photography but the Martin Marylands were slowly being lost and had to be replaced by the Douglas Baltimore in October 1942.

Losses of the Baltimores during photographic sorties led to the loan of two Mosquitos in February 1943. Flight R.A.F. 1434 was also based in the Middle East but had largely been involved air survey work in Iraq and also lacked suitable aircraft. Following Operation Torch, the allied invasion of North Africa the 5th, 12th, 15th and 23rd Reconnaissance Squadrons U.S. Army Air Force (USAAF) was deployed to North Africa where they formed part of the 3rd Reconnaissance group together with No. 682 Squadron R.A.F., No. 60 Squadron SAAF and the French Groupe de Reconnaissance GR II/33. No.682 Squadron had been equipped with two Mosquitos in April 1943 to carry out longer PR missions. On 22 March 1943 Fryer had written to General Dempsey the officer commanding No.1 Planning Staff outlining the problems in obtaining suitable photography over Sicily and was told that no survey aircraft were available for North Africa[30]. After a considerable struggle two Mosquitos were made available on 10 June and commenced sorties on 13 June, flying 19 sorties in all. However, as Fryer notes, 90% of the air photographs were taken too late for maps to be revised in time for Operation Husky. He argues that no revision is possible within two months of an invasion

30 FRYER, 1943, pp. 7–8 gives an account of the problems encountered in obtaining suitable aircraft which necessitated going right up through the chain of command to General Alexander, Commander in Chief, Middle East Command before Mediterranean Air Command Allied Forces Head Quarters would release the required Mosquitos for air survey operations. Appendix H is a copy of the letter sent by Fryer setting out the problem.

on the scale of Husky[31].

The lack of cooperation between the North African Photo Reconnaissance Wing and the surveyors led to the attachment of a survey officer to the Wing to select photography for mapping, inform the surveyors of what was available and to ensure duplicate films were provided to the War Office in London, War Department in Washington and to the Middle East Intelligence Unit. He was also required to obtain prints for the Survey Directorate, Allied Forces Head Quarters and to request areas to be flown for mapping and revision.

Following requests for additional Mosquitos, three were dispatched from the United Kingdom, but a sudden emergency led to their recall soon after arrival. The return of Mosquitos to the United Kingdom meant that the surveyors were reliant on the F4 of one of the U.S. PR squadrons to provide 6 and 24 inch photographic cover. Operating from 25,000 to 30,000 feet, the 6 inch cameras would have produced photographs of between 1:50,000 and 1:60,000. The 24 inch cameras would have produced photography between 1:25,000 and 1:30,000, but with much reduced cover compared to the 6 inch cameras. The photography obtained was used for revision of existing 1:50,000 and 1:25,000 mapping and new mapping at 1:25,000 where no sheets existed. The new mapping by the British involved the use of graphical methods, primarily radial line plotting. The arrival of the American 30 Engineer Topographical Battalion equipped with multiplex photogrammetric instruments led to their use in aerial triangulation to provide ground control where none was available, as well as for photogrammetric plotting, such as for 1:25,000 sheets of an area north of Rome in May 1944.

The copies of aerial photography supplied to the War Department in Washington were used by the U.S. Army Map Service (U.S.A.M.S.) to revise existing coverage and to provide new mapping of areas not previously mapped. Some of the mapping was provided as printed sheets, while others were provided as reprographic material for printing in North Africa or Italy. The form in which aerial photography was used is indicated in a note at the bottom left of the relevant map sheet. For example, 1:50,000 map sheet 89-III (Ravenna W.) has “Prepared under

31 Fryer, 1943, p. 7 on the revision of maps prior to Husky. Clough, 1952, pp. 50–-504 draws on Fryer for the discussion of air survey photography for Husky. Clough, 1952, pp. 339–342 includes a discussion of the air survey photography for the campaign in mainland Italy.

the direction of the Chief of Engineers, U.S. Army, by the Army Map Service (SO), U.S. Army, Washington D.C., 1944. Aerial revision by Army Map Service (GEAM), U.S. Army, Washington, D.C. 1944.", while map sheet 77B-I (Cherso) has "Prepared under the direction of the Chief of Engineers, U.S. Army, by the Army Map Service (GEAM), U.S. Army, Washington D.C., 1944. Compiled by stereophotogrammetric methods (multiplex) and by reference to Italy, 1:50,000, Sheet 77B-I, A.M.S., 1943". From this, it is possible to assume that the revision of the Ravenna W. sheet was revised by simple optical or graphical means, whereas the Cherso sheet was virtually remapped by stereophotogrammetry.

Aerial photography was also used to produce photo-mosaics[32]. The American artillery had trained using photo-mosaics for targeting and expected to be able to use them in Italy. However, training in the American Mid-West had taken place over relative flat terrain where the production of relatively easy, very different to that encountered in Southern Italy. In addition, photography in a defended air space made it much more difficult to achieve the kind of systematic coverage necessary for controlled photo-mosaics. A lack of survey resources and adequate ground control compounded the problem. In consequence, many of the photo-mosaics produced were only semi-controlled and used approximately rectified oblique photography, lacking the accuracy necessary for targeting. Half-tone reproduction also reduced their quality.

Relief Models

Relief models were used quite extensively by the allies during the Second World War. A general overview is given in Pearson[33]. Models had been prepared

32 Clough, 1952, p. 319.

33 Alastair W. Pearson, « Allied Military Model Making during World War II », *Cartography and Geographic Information Science* 29/3(2002), pp. 227–241, provides a good overview of the model making carried out in Europe and North Africa at a wide range of scales and for a variety of functions. A short version, providing a wider context is Alastair W. Pearson, « Relief Depiction: Relief Map, Relief Model, Relief Shading », in Mark Monmonier (ed.), *The History of Cartography Volume Six: Cartography in the Twentieth Century,* University of Chicago Press, Chicago, 2015, pp. 1260–1272. A purely American account is given in Herbert Milwit, *Engineer Model Makers Detachment,* Intelligence Division of the Office of Chief Engineer, European Theater, Paris, 1945. This account includes images of a number of models made of parts of Sicily and mainland Italy for amphibious operations. H.P. Reed, « The Development of the Terrain Model in the War », *Geographical Review* 36/4(1946), pp. 632–652, provides a good overview of the developments during the

for Operation Torch at a variety of scales from 1:2,000 to 1:100,000 for briefing troops due to take part in the operation. These models were produced in England by a joint team of British and American model makers in a period of intense work prior to the landings on November 8, 1942. Work was undertaken between November 1942 and August 1943 on models for the assaults on Sicily and Southern Italy. Work on the Sicilian and Italian models was carried out by a combination of teams in England and in Egypt. A 1:25,000 model was produced to cover the area from Mt. Etna to Pachino and westwards beyond Gela using information derived from Italian 1:25,000 and 1:50,000 maps supplemented by aerial photography. The whole model was mode in ten sections, each measuring 4.27 x 4.88 metres (14 feet by 16 feet). These models were illuminated to simulate the sun azimuth and elevation at the proposed time of assault and photographed obliquely to simulate an altitude of 152 metres (500 feet), the height at which the gliders would approach the coast. The sections for the American assault areas were then sent to Algiers.[34] A 1:4,000 scale model of Pantelleria was also produced in anticipation of an opposed occupation. Larger scale models, usually at 1:5,000 were produced of Syracuse, Gela, and Pachino in Sicily and Reggio and Crotone in Italy. A 1:10,000 model was also constructed of Taranto, which included ship locations and anti-submarine booms.

Various methods were used to create the models which are described in Pearson, Milwit and Reed. They were usually photo skinned to provide the plan detail, which was enhanced by painting and on the larger scale models the addition of physical objects to represent features such as buildings.

Conclusion

In a paper of this length it is not possible to cover the full range of military maps of Italy produced by the western allies during the Second World War. The focus has therefore been on those which would have been used by the armed forces either for planning or carrying out operations, the maps that ordinary soldiers and airmen would have used. A whole range of other maps were produced for strategic planning and reporting as well as maps for service personnel on leave in

war. A number of the images also appear in Milwit, 1946, implying that Reed was drawing on the same information and may have been involved in the same work.

34 Pearson, 2002, pp. 236–237.

Italian cities. A thorough combing of the archives would doubtless reveal many more. A common feature of nearly all the mapping considered here was its dependence on existing Italian mapping, with first editions frequently being direct copies of the Italian originals and only subsequent editions being revised from other sources. In a number of ways, the mapping of Italy gave the allies valuable experience for the subsequent mapping of France especially of the intended invasion areas although the work has been largely ignored in the literature on Second World War mapping.

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