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Historic Maps of Terrain Evaluation

Keywords

Military geography, military geology, maps for general terrain evaluation, going-maps, tank maps, combined method.

Abstract

Historic military maps of eight decades show the different methods of terrain evaluation of battlefields and thematic maps for military commands. For tactical purposes we refer to the combined method based on the expert knowledge of military geoscientists, such as applied geographers, geologists, meteorologists, hydrologists, soil scientists, vegetation scientists and others.

1 Introduction

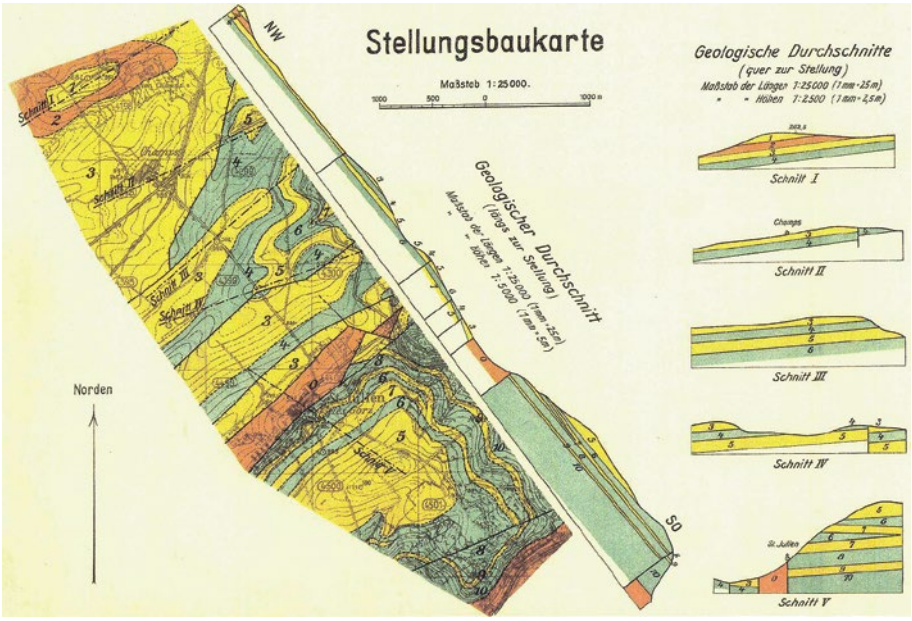
Long before digital geographic information systems were available, experienced military geoscientists assessed the battleground of areas of operation. Terrain evaluation was an issue for the armies in World War I, and more extensive for the Axis powers and the Allies in Europe and Northern Africa during World War II. And it was of importance during the Cold War as well.

Geographers, geologists and other geoscientists with good knowledge of foreign countries (and language abilities) and with good contacts to research institutions during peacetime were commonly chosen as military experts during wartime. At the beginning of World War I and II, many armies neglected the extended need for topographic maps and terrain evaluation. During a war and towards its end the use of topographic and thematic maps at different scales usually increased. Newly established offices provided regional and local maps and military geographic teams as well as military geological teams were attached to army staffs. The author recorded terrain evaluation maps of the Austro-Hungarian Monarchy and of Germany from the First World War (H. HÄUSLER, 2000 a) as well as from the attacking and retreating German armies of the Second World War (H. HÄUSLER, 2000 b).

This paper presents a review of terrain evaluation maps in order to demonstrate military geo-scientific knowledge prior to the use of computer graphics and geographic information systems. We state that these historic examples of somehow integrated terrain evaluation provided by military geo-experts of the last 80 years are not old fashioned in terms of combining data and map design.

2 World War I

European theatres of the First World War are characterised by more static warfare and, therefore, field fortifications played a major role in defence. For this purpose, military geologists of the German armies provided thematic military geologic maps derived from local geologic maps and specific field surveys. For fortification, the height and seasonal variation of the groundwater table and the resistance of formations to ditching was important.



Schichtenfolge	Gesteinsart	Mächtigkeit	Standfestigkeit	Bearbeitbarkeit	Verhalten gegen Wasser	Gräben u. Stollen	Art der Entwässerung
0	weicher, rostgelber od. blaugrauer, zerrütteter Ton	unbestimmbar	sehr gering	leicht	wasserstauend (Überschwemmungsgefahr!)	Gräben: sehr naß u. verschlammt Stollen: ertrinken	für Gräben: sorgfältiges Einwägen, Ausnutzung des natürlichen Gefälles. – Abzugsgräben. für Stollen: Ausheben von Abzugsgräben um den Stollen vor dessen Anlage. – Abdichtung der Schleppschächte im verwitterten Gestein durch Tonhinterstampfung evtl. des ganzen Stollens. – Stollen im Ton 3 meist noch durch Sickerschächte entwässerbar
1	weicher, toniger Mergelkalk	10–14 m	gering	mittelschwer	sehr wenig durchlässig	desgl.	
2	dunkler, fetter Ton	10 m	sehr gering	leicht	vollkommen undurchlässig	desgl.	
3	Mergelkalk darunter Ton	7 m	mäßig	mittelschwer	wenig durchlässig	meist naß u. verschlammt	
4	harter, klüftiger Kalk	7 m	sehr gut	schwer, z.T. sprengen	durchlässig	gut u. trocken	—
5	Mergel dazwischen gelagert Kalk	wechselnd zwischen 5 u. 15 m	mäßig	mittelschwer	schwach durchlässig	feucht	für Gräben: Einwägen und Abzugsgräben für Stollen: stellenweise durch Sickerschächte zu entwässern
6	Kalk und Mergelkalk	im Norden 4–6 m im Süden bis 15 m	ziemlich gut	mittelschwer	ziemlich durchlässig	meist gut u. trocken	—
7	Mergelkalk stellenweise mit Kalklagen	im Norden 15–20 m im Süden abschwellend	mäßig / gut	mittelschwer	wenig durchlässig / durchlässig	gut u. trocken / häufig feucht u. verschlammt	— / — wie bei Nr. 5
8	klüftiger, bankiger Kalk	ca 75 m	sehr gut	schwer, z.T. sprengen	durchlässig	gut u. trocken	—
9	Mergelkalk	ca 5 m	gering	mittelschwer	wenig durchlässig	naß	fast immer durch Sickerschächte zu entwässern
10	sehr harter, klüftiger Kalkfels	ca 60 m	sehr gut	z.T. sehr schwer, sprengen	durchlässig	trocken	—

Figure 1: German map for field fortification from WWI at original scale 1 : 25 000 (CHEF DES KRIEGSVERMESSUNGSWESENS, 1918).

Figure 1 shows an example of a large scale German map for field fortification. Names and scientific details of formations were not included, but for military purposes a *translation* of the distinctive features and attributes of hard rock and soft rock formations was provided for the soldier. Thus the legend of ten beds of different geologic ages comprises the rocks themselves (*Gesteinsart* instead of the formation name), their varying thickness (*Mächtigkeit*), stability (*Standfestigkeit*), diggability (*Bearbeitbarkeit*), permeability (*Verhalten gegen Wasser*), suitability for ditching and tunnelling (*Gräben und Stollen*), and advice for drainage (*Art der Entwässerung*). The geologic sections corresponded to the map and were easily readable for non-geologists.

Another outcome of geologic map interpretation and additional geologic field survey were the so-called *mining maps* (see figure 2). Such maps provided detailed information for engineers on highest groundwater level for tunnelling, on the occurrence of several

Figure 2: German mining map from WWI at original scale 1 : 25 000 (CHEF DES KRIEGSVERMESSUNGSWESENS, 1918).

groundwater layers (aquifers) and showed areas for mining possibilities at depths of 6 - 9 meters and deeper. In addition, isohypses of dry rocks below the main aquifer were drawn and comments on the use of spades and pickaxes were given.

3 World War II

Thematic maps of military geologic teams during the Second World War reflect rapid mobile warfare and, therefore, very often deal with *off-road trafficability*. At that time they were termed *going-maps*. For the arrangement of mechanised brigades, large areas were assessed and going-maps were printed at regional scale.

3.1 Going-Maps of Northern Africa 1 : 500 000

Figure 3 is an example of the legend of a printed going-map 1 : 500 000 of the North African theatre in 1941, which was provided for the *Long Range Desert Group* (L.R.D.G.). British forces employed no military geologists as such, but very experienced officers of the British Army classified the terrain for the movement of mixed mechanised forces.

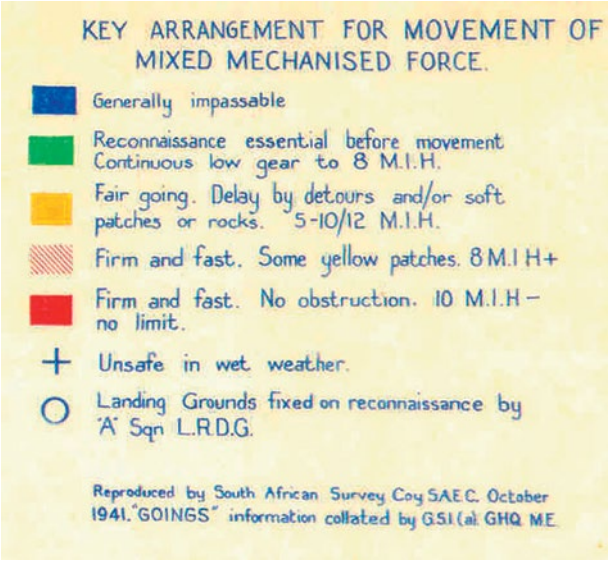


Figure 3: Legend from a printed British *going-map* 1 : 500 000, sheet BARDIA, in Northern Africa (H. HÄUSLER, 2003; figure 23).

The British *military engineer* of the *General Head Quarters* classified the landscape of Northern Libya for the general movement velocity of military convoys in the desert, based on the pragmatic values of 8 - 10 miles per hour (equalling 12 - 15 km/h).

The military geologic team no. 12 attached to the Tank Army Africa of General Rommel at the same time provided detailed going-maps 1 : 500 000, based on geologic maps, reconnaissance flights, aerial photo interpretation, and the field survey of selected areas (see figure 4, p. 261). These maps were copied and coloured by the military geologic team itself,

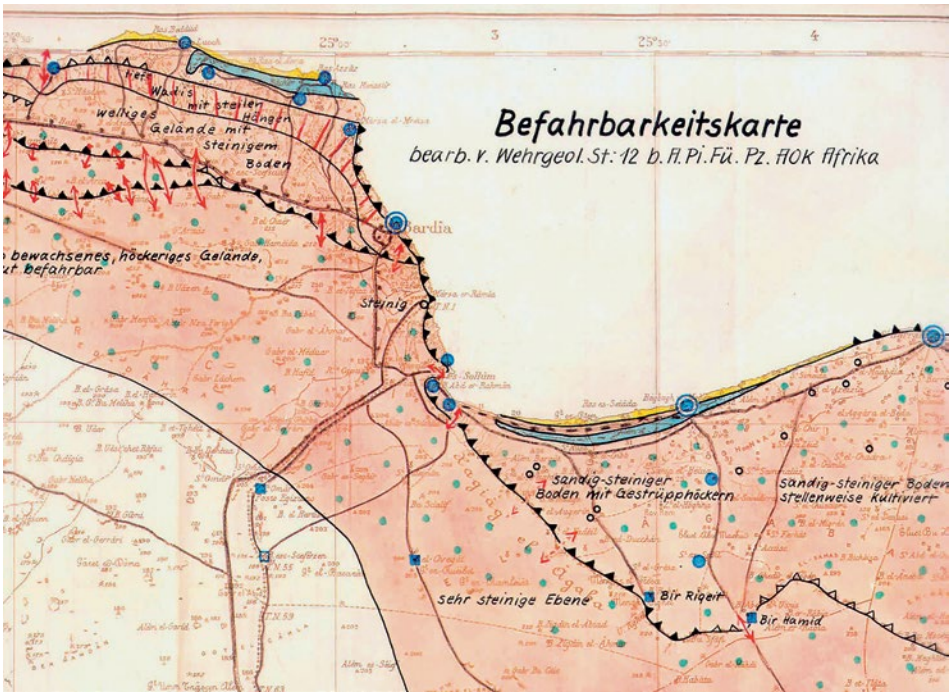


Figure 4: Section of a hand-coloured German going-map (*Befahrbarkeitskarte*) 1 : 500 000, sheet BARDIA, Northern Africa (H. HÄUSLER, 2003; figure 12; reproduction not to scale).

whereas similar maps were printed by the Italian Army at a scale of 1 : 400 000 (*Carte dimostrativa della Libia Scala 1 : 400 000*), the legend of which resembles more the British going-map.

3.2 The German Combined Method of Terrain Evaluation

In 1941 the German Counter Intelligence Service of the Armed Forces High Command founded a joint military-geoscientific reconnaissance team, the so-called *Sonderkommando Dora* to update maps of the frontier between Libya and Chad. In 1943, this research group was termed *Forschungsstaffel z.b.V.*, where *z.b.V.* was short for "*zur besonderen Verwendung"* meaning *for special utilisation* by high military commands. The *Forschungsstaffel's* unique core competence in military geosciences lay in the integration of all literature and maps available at different institutions and local field studies supplied by reconnaissance flights. Depending on the military demand, the military geoscientific team consisted of geographers, cartographers, geologists, soil scientists, vegetation scientists, meteorologists, astronomers, hydrologists, and road engineers. In addition, universities and governmental offices supported the *Forschungsstaffel*. The normal procedure was that within a few days after order this team classified landscapes according to the purpose demanded, such as water supply; air landing zones, going-maps for tanks, or general terrain evaluation. It evaluated test areas by field mapping or reconnaissance flights, produced aerial maps to scale and printed the thematic maps for distribution to the army commands.

The results of these integrated surveys were printed as special maps at different scales, as for instance river maps 1 : 25 000, tank maps at scales varying from 1 : 50 000 up to 1 : 200 000, special maps for air landing zones 1 : 200 000, maps of Russian swamp areas 1 : 300 000 and small scale maps at 1 : 500 000. The maps of the *Forschungsstaffel* were not termed terrain evaluation maps as such but *maps for terrain evaluation*, meaning that the user himself had to interpret the classified maps for his special purpose. To demonstrate the method developed by the *Forschungsstaffel z.b.V.* we present the following examples of different scales:

- Going-map of the Pripjet swamps 1 : 300 000,
- General terrain evaluation map of South-eastern Europe 1 : 200 000,
- Tank map 1 : 100 000, and a
- Detailed terrain evaluation map of Ukraine 1 : 50 000.

3.2.1 Going-Map of the Pripjet Swamps 1 : 300 000

A very interesting example of terrain evaluation during World War II refers to the wetland and swamp area of the Pripjet-region in Eastern Europe, which was assessed as impassable by the German Armed Forces High Command (*Oberkommando der Wehrmacht*) before the attack of German armies in 1941. This was wrong, however, as proofed by a special terrain evaluation unit (*Forschungsstaffel z.b.V.*) set up by the German Counter Intelligence Service. In 1944, this team provided the retreating German armies with going-maps (*Durchgängigkeit des Pripjet-Gebietes*) 1 : 300 000, which were the result of a rapid assessment of that area by a team consisting of cartographers, geologists, vegetation scientists, and soil scientists supported by aerial flights and field checks through reconnaissance teams (see figure 5).

Figure 5: Map 1 : 300 000 of the Pripjet swamp area (Reproduction not to scale; courtesy of the Prussian Culture Foundation).

3.2.2 Terrain Evaluation Maps 1 : 200 000

The standard scale of printed topographic maps for German army commands in the Second World War was 1 : 200 000. Army topographic units edited foreign topographic maps, added the German military 2 km-grid and copied them in mobile field print offices. These maps were the basis for the production of terrain evaluation maps by military geography teams, military geology teams or special research groups, such as the *Forschungsstaffel z.b.V.* Figure 6 shows an example of a printed *terrain*

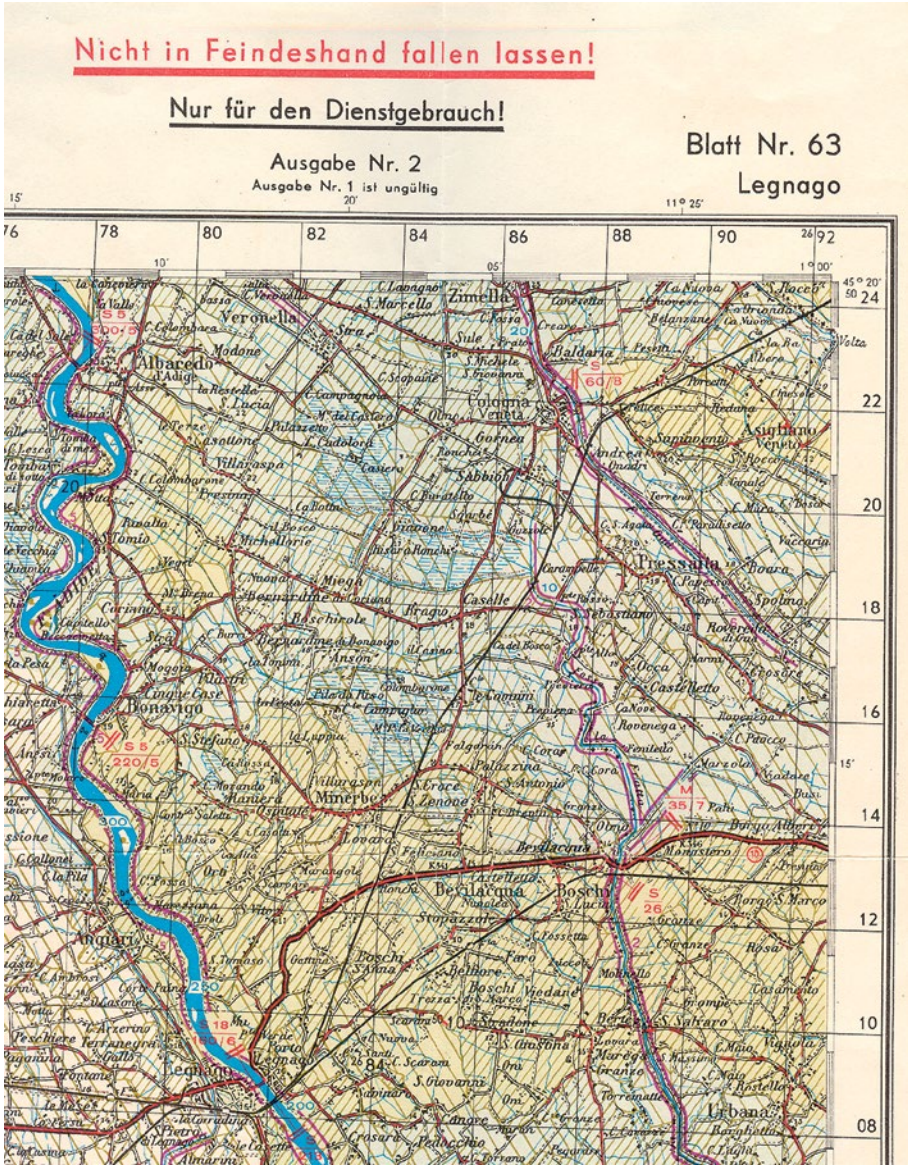


Figure 6: Map 1 : 200 000, Legnano, Italy.

evaluation map 1 : 200 000 of the Adige valley near Legnano, Italy, provided by the *Forschungsstaffel z.b.V.*

The geomorphology of the flat Adige Valley was classified with regard to linear and two-dimensional features which were of importance for the mobility of wheeled and tracked vehicles as well as for air landing zones for both paragliders and parachutists. The legend of the landscape features comprises military aspects of rivers and wetland (blue), of up to 5° inclined ground (bright blue and green), broken terrain (hatched brownish), and permanent air landing zones (signature only visible when holding the map against the light). The numbers above the rivers indicated their widths in meters at mean water level. The number above the violet lines indicated the height of the dam crown in meters above the surrounding terrain, which allowed for calculating flooded land in case of a dam burst. Additionally, a red formula was given to important bridges exceeding 15 meters in length. Material (concrete, steel, masonry) and tonnage was given in the numerator and

Figure 7: Detail of a terrain evaluation map 1 : 200 000 of Bozen Province (Military geologic archives of the author, reproduction not to scale).

the length between the end trestles as well as the width of roadways in the denominator. The northernmost bridge crossing Adige River near Albaredo (see figure 6, p. 263) e.g. was classified as steel bridge (S) with a bearing capacity of 5 tons (5), a width of 300 meters between the end trestles (300) and a road of 5 meters in width (5).

Special advice was printed in violet, i.e. that the terrain evaluation map was help for terrain evaluation for the own purpose of the staff and the troops only and did not make up for local reconnaissance.

Other military geologic teams or military geographic teams developed their own standards of terrain evaluation maps, even at the same scale. Figure 7, p. 264, gives an example of a terrain evaluation map 1 : 200 000 provided by the military geographic group (*Mil.-Geo.-Gruppe*) of the German Commander-in-Chief Southwest.

In this map the terrain representation by hachure is enhanced by thick black lines for steep rocky slopes and by narrow black contour lines for narrow valleys. Red lines enhance main roads; red broken lines and red dotted lines indicate good ways for soldiers and mules. Circled numbers refer to passages described in a textbook.

3.2.3 Tank-Map 1 : 100 000

Figure 8 shows a detail of a printed off-road trafficability map provided by the *Forschungsstaffel z.b.V.* for the retreating German armies in Italy. Figure 9, p. 266, is an example of the legend of a special edition tank map (*Panzerkarte*) 1 : 100 000.

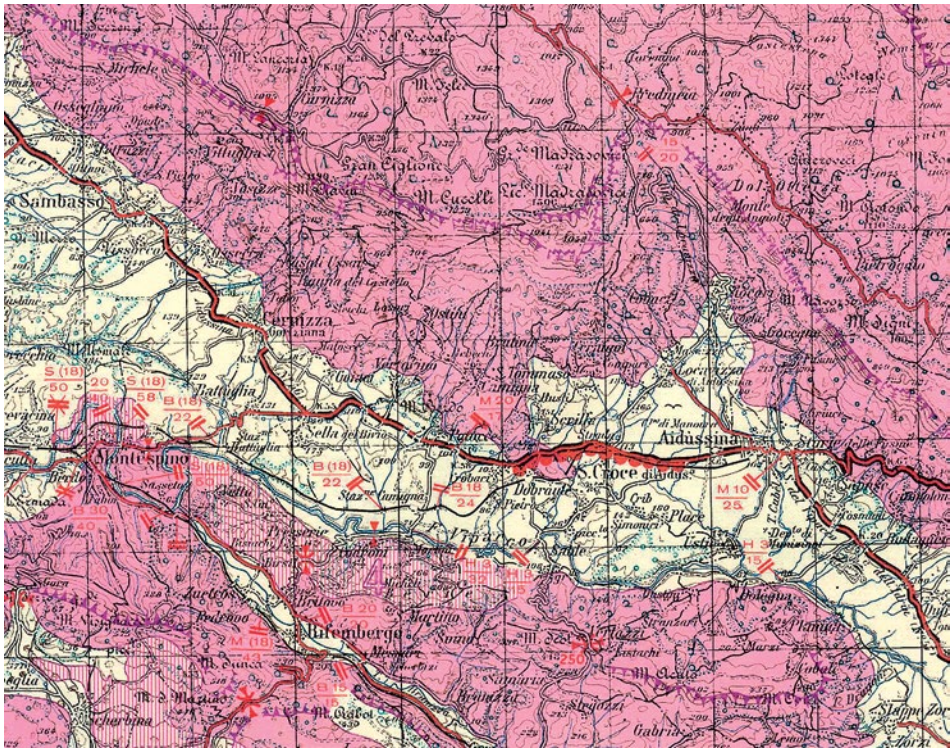


Figure 8: Detail of an off-road trafficability map 1 : 100 000 (reproduction not to scale; courtesy of the Prussian Culture Foundation).

Legend
Off-road terrain trafficability for armored tracked vehicles

	Go;	Hard rock formation with thin loam cover
	Uncertain go-conditions;	**5** = On karst plateau flat sinkhole ponds, flat ridge and rock walls **8** = Steeply dissected hills and mountains in flysch zone
	No-go;	Very karstified plateau and steeply sloped mountain area
	Terrain steps	
	Inclined slope (oblique slope);	Slope inclination less than 30°. Loamy soils slippery when wet during rain periods.
	Steep slope Dams and dikes;	Slope inclination exceeding 30°
	Rock wall;	
	Forest	
	Timber forest	
	Brushwood	
	Roads, Bridges and Others	
	Two-laned road, firm	
	Single-lane road, firm	
150	Street tunnel with length in meters	
600	Road high pass with altitude	
	Snowbank along through road	
	Good location for obstacle along road or railway	
	Important view point: panorama or sector	

Figure 9: Legend of a special edition Panzerkarte 1 : 100 000.

3.2.4 Konka Map 1 : 50 000 (Ukraine)

Special reconnaissance flights over Ukraine and the interpretation of aerial stereo pairs by plant sociologists as well as the terrain evaluation of test sites led to the *Konka Map 1 : 50 000* (see figure 10, p. 267). Nine landscape types were mapped jointly by military geographers and by geologists of the military geologic units 6 and 16 which, in September 1943, were attached to the Tank Army High Command 1 in the East, and to the Army Group South (*Heeresgruppe Süd*), respectively.

Although the map design looks clear and simple, the legend is quite complex, again briefly describing surface, soil and groundwater of the nine landscape units and contain-

Figure 10: Preliminary map 1 : 50 000 of the Konka depression, Ukraine (E. BOEHM, 1989, reproduction not to scale; courtesy of the Austrian Academy of Sciences).

ing conclusions for trafficability, field fortification as well as protection and camouflage. The map clearly shows swamp areas and lakes (blue), reeds (blue lines; *Schilffelder*), meadows (green), flat pasture land (green lines), flat sandy areas (red lines), sand dunes up to 3 - 7 meters (brown: *Sanddünen*), sand embankments along the River Dniepr (brown with black dots), 2 - 7 meters high willow bushes (*Weidengebüsch*), and dry riparian forests (dark green). In addition, lines for middle and high water were added.

3.2.5 Local Maps for German Armies

Terrain evaluation has a long tradition in the armed forces of Austria and Germany, dating back to the First World War, when in total 200 German war geologists produced some 5500 military geologic reports, many of which contained large scale thematic maps (H. HÄUSLER, 2000 a). Uncountable military geologic reports from about 350 German military geologists of 40 military geologic units in the Second World War also provided specific terrain evaluation maps on request. Figure 11, p. 268, shows a detail from a hand-coloured copy of such a report dating from November 1944 for a retreating German army near the River Weichsel in Poland. This thematic map 1 : 10 000 resulted from a general geologic map 1 : 100 000, from aerial photo interpretation, and from geologic and geomorphologic field surveys of the military geologist attached to the army engineers of the Tank Army High Command 4.

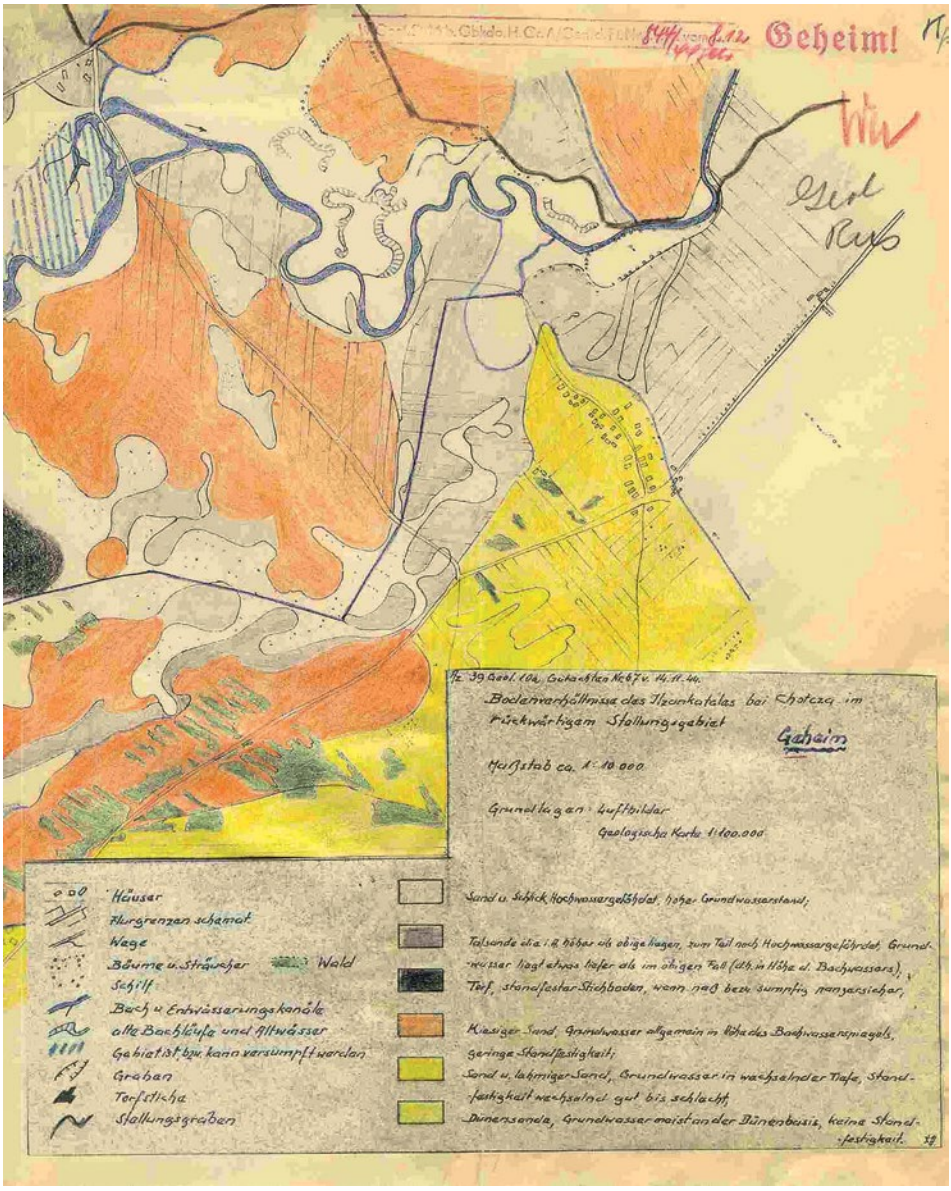


Figure 11: Detail of a military geologic map 1 : 10 000 of the River Weichsel south of Stopnica (Military geologic archives of the author, reproduction not to scale).

4 Cold War

During the Cold War period, *Cross-Country-Movement* (CCM)-maps at scales 1 : 50 000 and 1 : 250 000 were used by the NATO-partner country Germany for its eastern region bordering the Warsaw Pact countries. At that time also military geology officers

of the Austrian Armed Forces provided *Trafficability Maps* of the eastern regions of Austria bordering (former) Czechoslovakia and Yugoslavia at a scale of 1 : 50 000. For that purpose soil maps were classified with regard to soils affected by high groundwater and by strong precipitation. Therefore the legend of the going-maps 1 : 50 000 comprised dense wood, villages, no-going areas with high groundwater (red) and no-going areas after heavy precipitation (orange). The map shown in figure 12 was provided for the Austrian Armed Forces high commands during the Yugoslavian crisis in 1991.

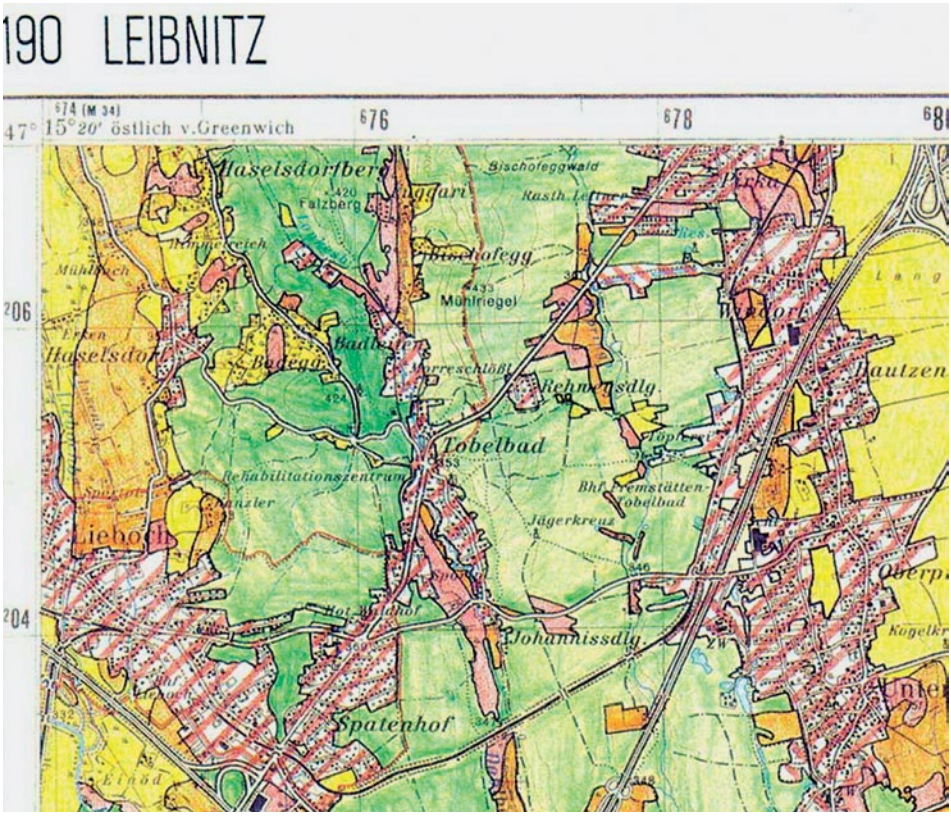


Figure 12: Colour copy of a 1 : 50 000 terrain trafficability-map of Southeast Austria (Military geologic archives of the author, reproduction not to scale).

5 Conclusion

If lessons can be learned from suffering through cruel wartimes, it is a matter of fact that terrain evaluation never was an important issue *at the beginning* of hostilities. But it always became a decisive factor when natural resources were over-exploited and bad weather hindered military activities. As a consequence, the organisation and training of military geoscientists was always *weak* when a war was declared and became *strongest* when the hostilities came to an end.

As the *European Security and Defence Policy* (ESDP) underwent a fundamental change after the fall of the Iron Curtain in 1989, terrain evaluation of European countries lost its

previous importance. However, the *Petersberg Tasks* again stipulated terrain evaluation of operational areas for humanitarian and rescue tasks, peacekeeping tasks and tasks of combat forces in crisis management, including peacemaking.

The use of *geographic information systems* (GIS), remote sensing data, Internet databases, *computer aided design* software (CAD) and computer visualisation tools tends to result in avoiding the classical methods of terrain evaluation, including ground checks. Consequently, when proper data-based terrain evaluation software is not available, the knowledge of military geoscientists is still needed. Based on the experience of military geoscientists of the last century, software tools could be developed which provide applied geoinformation within an integrated military geoscientific expert system.

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