Chapter 5
Military Geoscientific Materials for Excursions to Theatres of First World War in France and Belgium

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Introduction

This paper presents military geoscientific aspects of excursions to the main theatres of First World War in Western Europe – the Verdun area in France and the Flanders area in Belgium. The first part deals with the geospatial preconditions which led to the so-called trench war, and the second part will give some geological details of these battlefields. Figure 5.1 provides an overview of the geographic and political situation in Central Europe at the beginning of the WWI in 1914.

In the west, the United Kingdom and France (blue) opposed the so-called Central Powers of Germany and Austria-Hungary (red). These two opposing parties were separated by a corridor of neutral states, the Netherlands, Belgium and Luxemburg in the north and partly by Switzerland in the south.

This boundary situation of the Central European countries dates back to the war between Germany and France in 1870–1871. After winning that war, Germany had annexed Alsace and the German-speaking part of Lorraine. As a consequence, France considered how to avoid another German invasion in the future, and Raymond Serré de Rivière, general of the engineers, proposed a line of strongholds paralleling the new border. This line was later on called the "Iron Line", and four outstanding cities in France were representative for it, namely, Belfort, Epinal, Toul and Verdun (Fig. 5.2).

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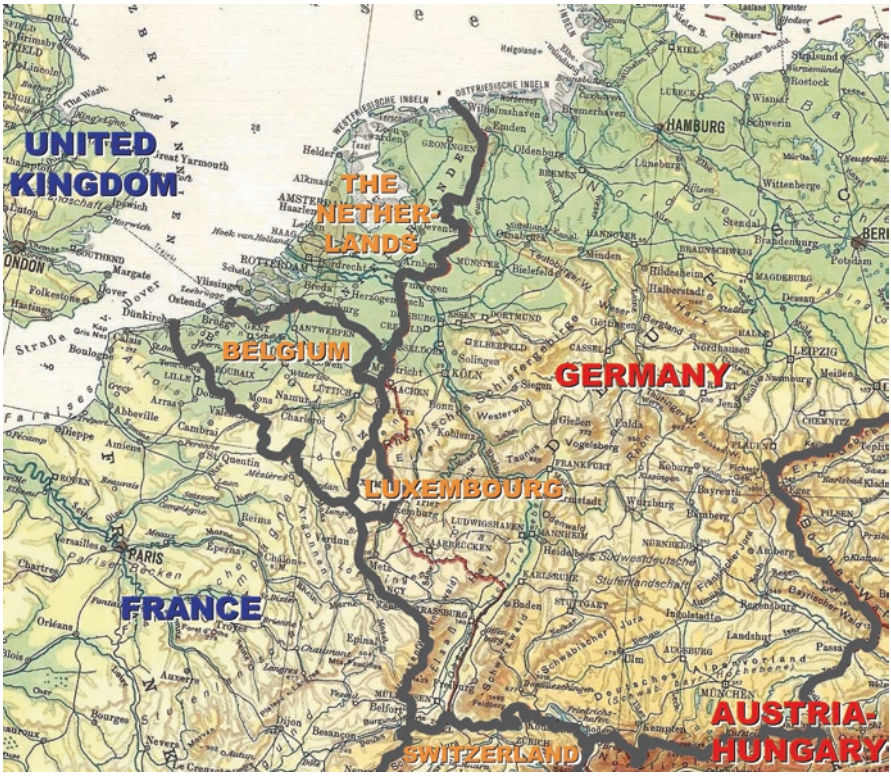

Fig. 5.1 The opposing countries (red and blue) of Central Europe in 1914. (Base map from historical atlas published around 1900)

From Mobile Warfare to the "Trench War"

The German general staff was of the opinion that there was only one way to successfully defeat France again – invading France by marching through the neutral countries of Luxemburg and Belgium. A very strong "right wing" of the German armies would invade Belgium and Luxemburg and then enter France, surrounding Paris in the west and then appearing in the back of the "Iron Line". Germany's plan was to defeat France within a few weeks and only then bring considerable military forces to the eastern front against Russia to avoid the dreaded "two-front war". This plan was later on called the "Schlieffen Plan", termed after the former German chief of staff Field Marshal Alfred von Schlieffen (1833–1913), who always stressed "Keep the right wing strong".

Figure 5.3 displays nine important steps of the Schlieffen Plan which were presented at the ICMG Conference in Quebec in 2007. On August 2, 1914, the Germans started an offensive in the north, whereas the French twice attempted to invade

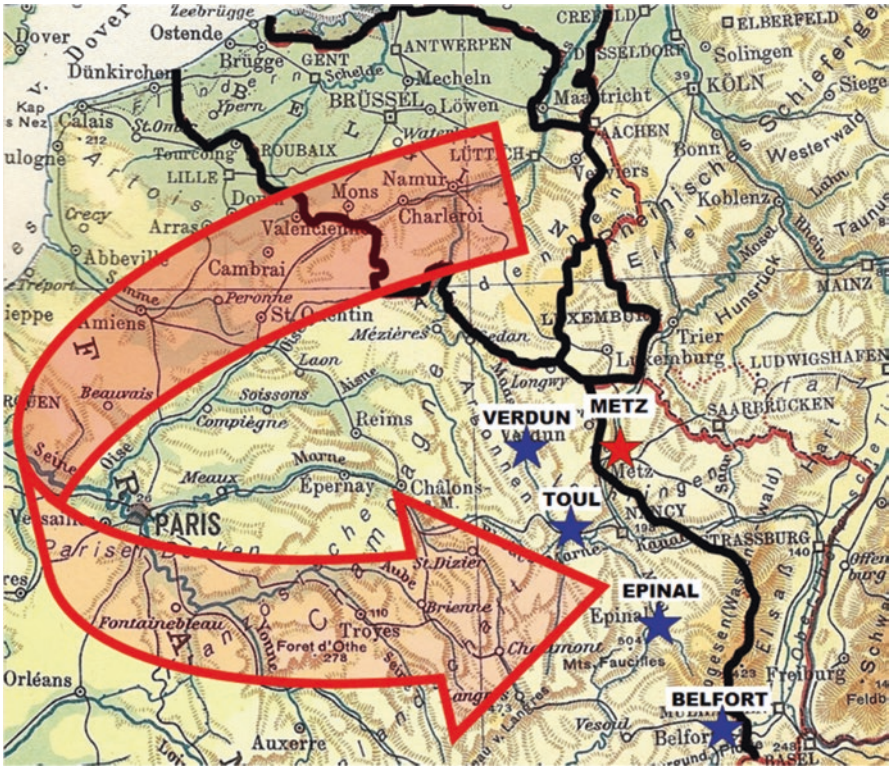

Fig. 5.2 The "Iron Line" of French fortresses (blue stars) and the German "Schlieffen Plan" (red arrow) in 1914. (Base map from historical atlas published around 1900)

Alsace in the south. Later on, the Belgian army retreated into the fortress of Antwerp, and therefore the Germans diverted two corps from their right wing to besiege Antwerp.

When the Russian army invaded Eastern Prussia, further, two corps were removed from the right wing to support the German armies in Eastern Europe. In addition, yet another German corps was removed for the besieging of Maubeuge on August 24. At this point, the German right wing had been weakened by a total of five corps, which is the equivalent of about one whole army, a possibility which had not been taken into consideration. It is likely that at this stage the Germans recognized that they did not have sufficient strength to surround Paris from the west as planned. As they moved southwards to pass Paris to the east, they opened a flank to the still effective French and British forces. The southernmost line the Germans achieved was south of the river Marne. Due to German communication problems, contradictory assessments of the situation and counterattacks by the Allied forces, the German forces were forced back, and it became evident that the "Schlieffen Plan" had failed. This withdrawal is known as "The Marne Miracle".

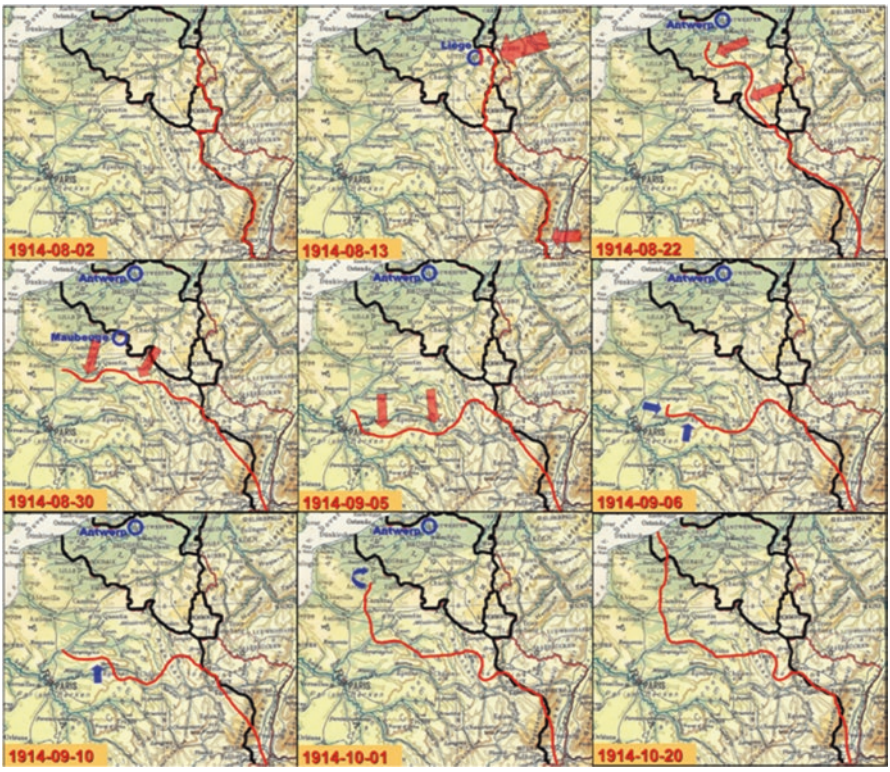

Fig. 5.3 Important steps of German operations on the Western Front dating from August 2 to October 20, 1914. The red line indicates the German front. Red arrows show attack, and blue arrows show the retreat of the German armies. (Base map from historical atlas published around 1900)

Later on a number of attacks and counterattacks occurred on the German northwestern flank. The opposing parties tried to outflank each other in the direction of the North Sea, and later on these operations were called "The Race to the Sea".

The Race to the Sea finally stopped at the harbour of Nieuwpoort, when the Belgians opened the locks separating the River Yser from the North Sea. By flooding the flat area between Nieuwpoort and Ypres (Fig. 5.4), they stopped the German troops, and for the next 4 years, Flanders and Verdun became the centres of the so-called trench war (Fig. 5.5).

In winter 1914, the Western Front stabilized along a line bordering Northeast France (Belfort–St. Die–Nancy–Toul–Verdun–Reims–Soissons–Arras, up to Lille and Ypres; see Fig. 5.6), and the armies tried to use the properties of the ground to their best advantage. Material for military geographic and geologic excursions along the Maas Valley and to Verdun in France and along the Yser valley and the Ypres Salient in Belgium is described using evidence acquired from military atlases, military historic excursion guides 1:140,000, historic military geology maps

Fig. 5.4 Map of area situated below sea level (blue) and troops in Northern Belgium in October 1914 (modified after Birken and Gerlach 2002, left; courtesy of Philathek publishers). Harbour of Nieuwpoort with algae-covered concrete ramp indicating height of tidal change (right; photo taken by Reinhard Mang, 1 July 2006)

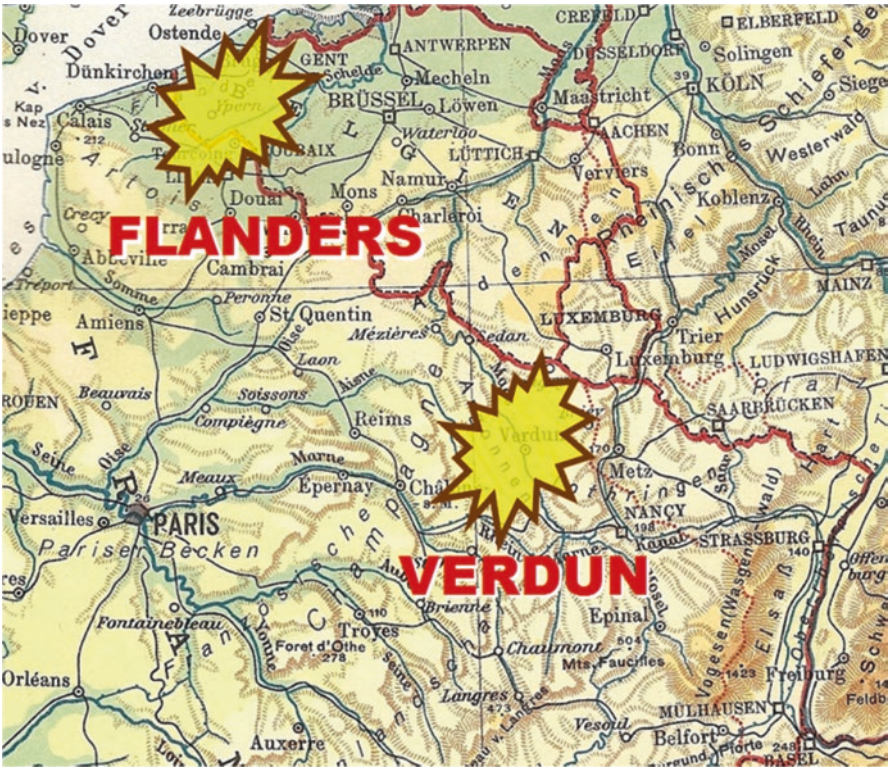

Fig. 5.5 From October 20, 1914, Flanders and Verdun became the centres of trench warfare in Western Europe. (Base map from historical atlas published around 1900)

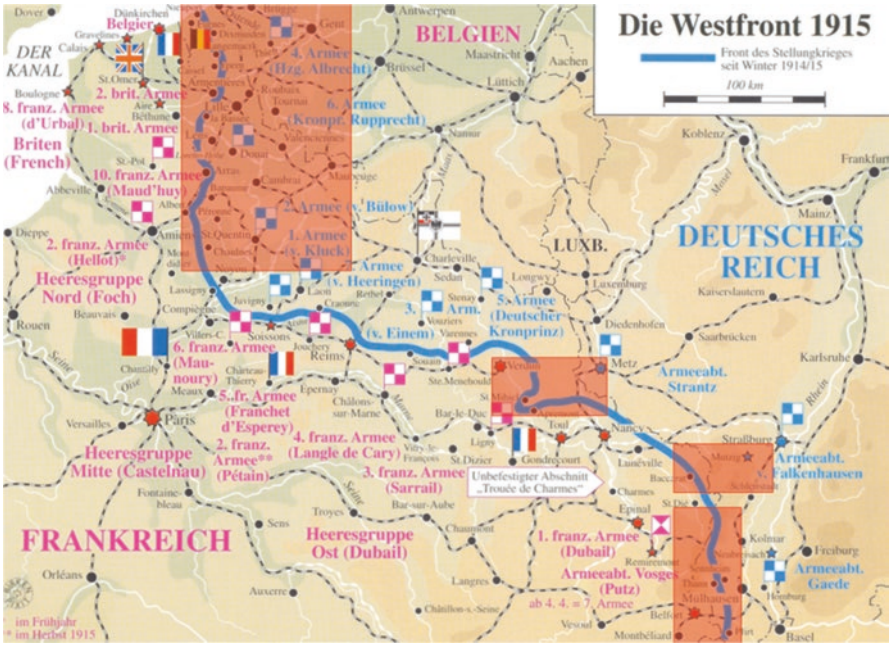

Fig. 5.6 Overview of deployment of military geology groups to the "Armeeabteilung Gaede", "Armeeabteilung Falkenhausen", "Armeeabteilung Strantz" and the "Herzog Albrecht's Fourth Army". (Modified after Birken and Gerlach (2002, courtesy of Philathek publishers))

1:300,000, local terrain evaluation by military geologists of the First World War, (Kraus 1918; Wilser 1927), exhibitions of war museums and excursion guides to the battlefields. For the study of military history, we refer to the information provided by war museums and to modern atlases (Birken and Gerlach 2002; Klauer 2004; both written in German).

Military Geology of the "Trench War"

General field guides to the geology of the Western Front have been published in German (Verdun: Sturm 1923; Alsace: Kraus and Wagner 1924; Lorraine: Kraus and Klüpfel 1925) and in English (Doyle 1998, 2000; Doyle et al. 2000, 2002; Chasseaud 2002). German war geologists published their experiences in a paper on "War Geology" which was edited by the chief of war cartography in January 1918 (Chef des Kriegsvermessungswesens 1918) and another by Dr. Ernst Kraus, who headed a military geology unit from 1916 on (Kraus 1918, 1919). In addition, the war geologist Dr. Walter Kranz reported case studies of mining and trenching (Kranz 1935, 1936a, b, 1937), and he also coedited a textbook on military geology (Bülow et al. 1938; see also G. Keller 1936).

The organisation of the British military geology at the Western Front in May 1916 comprised two geologists of the Royal Engineers. Lieutenant (later Captain) William Bernhard Robinson King was working as a staff officer to serve with the chief engineer (later retitled engineer-in-chief) of the British Expeditionary Force. Major (later Lieutenant Colonel) Tannatt William Edgeworth David provided specialized geotechnical maps illustrating the relative suitability of the ground for dugout construction. In 1915 9 British tunnelling companies and in 1916 25 Allied tunnelling companies comprised in total 25,000 men who were actively engaged in mining (Rose et al. 2000). In late 1916 and in 1918, three more geologists were attached to tunnelling companies (Doyle et al. 2000).

The organisation of the German military geology at the Western Front comprised about 60 war geologists organized into geology groups. These military geology groups were attached to the geodetic survey ("Kriegsvermessungswesen", Häusler 2000), and therefore each geology group advised an army or army corps in the west. In total, several thousand military geological expert opinions, both oral and written, explained soil and subsoil conditions for water supply, drainage of trenches, aggregates, dugouts and mining from 1915 to 1918.

From December 1916 onwards, one geology group was attached to the General Gaede's Armeeabteilung (later termed "Armeeabteilung B" or short A.A.B.; Fig. 5.6). The group was located at Colmar and comprised five military geology units at the front. At the Western Front, 12 German military geologists, 12 additional geologists, 9 technical personnel and 25 privates provided 13 military geology maps 1:10,000, 11 military geology maps 1:25.000 and about 1000 military geology expertises (Kraus 1919).

Another military geology group was attached to General Falkenhausen's Armeeabteilung (later "Armeeabteilung A" or A.A.A.) and was headed by Major Dr. Walter Kranz and Lieutenant Dr. W. Wagner.

Verdun

Although someone visiting Verdun will be presented with renovated trenches and a large selection of books, brochures, maps and videos, there is no specific information on the terrain itself. This leads to a lack of understanding of the military geography and for the military geology of the battlefield between the Argonne Woods and Woëvre plain, where 360.000 French and 330.000 German troops died fighting for only 5 kilometres of terrain between February 1916 and August 1917. Geologically, this area is composed of limestone and marlstone of Upper Jurassic age. Due to tectonic tilting of these formations, limestone beds more resistive to erosion form steeper flanks bordering the Maas Valley in the west, which are termed "Côtes de Meuse" (Fig. 5.7).

In November 1915, one military geology group was attached to General von Strantz's Armeeabteilung (later "Armeeabteilung C"; in short A.A.C.) in the

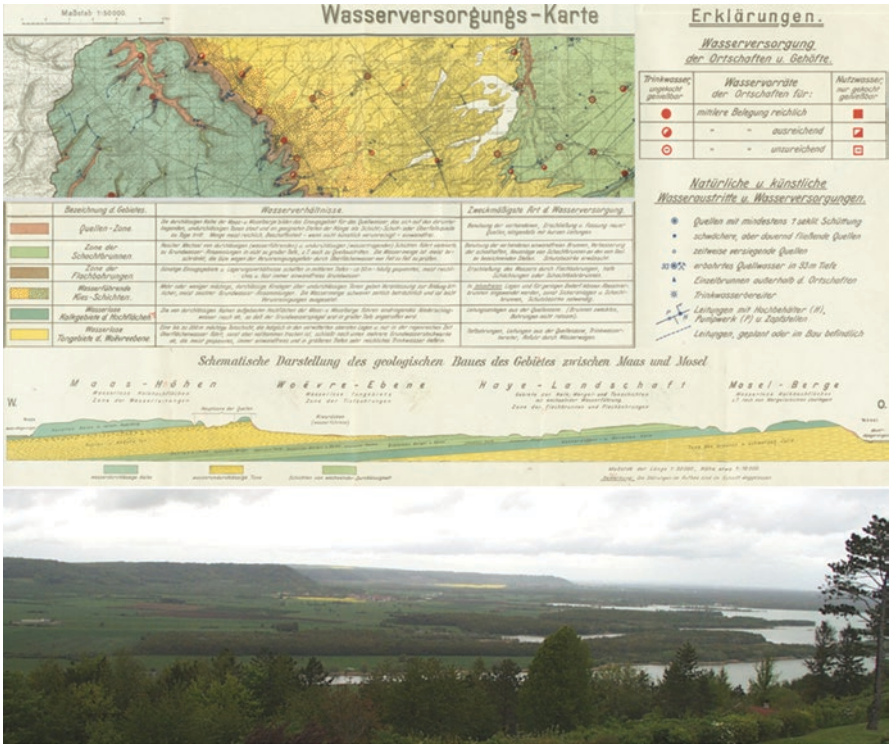

Fig. 5.7 Section of the geological map at original scale 1:50.000 with legend and explanations for drinking water supply ("Wasserversorgungs-Karte", Chef des Kriegsvermessungswesens 1918). The geological profile depicts escarpments of permeable, karstified limestone of Jurassic age overlying impermeable claystone forming gentle hills. View on "Côtes de Meuse" in the Maas Valley. (Photo taken by Hermann Häusler, 5 May 2004)

Verdun–Metz sector of the German front. It was headed by university professor Lieutenant Dr. Hans Philipp and comprised 6 military geology units of 28 military geologists in total. For tunnelling, mining and water supply, about one dozen German war geologists assisted General Stranz's army in the Verdun sector. German mining and galleries of the front sector of General Gallwitz ("Gallwitz-Tunnel") are presented on numerous panels in the field.

Flanders

In November 1915, Dr. Wilfried von Seidlitz headed the military geology group attached to Duke Albrecht's Fourth Army. This military geology group reported to the staff officer of the geodetic survey of the Fourth Army high command. The

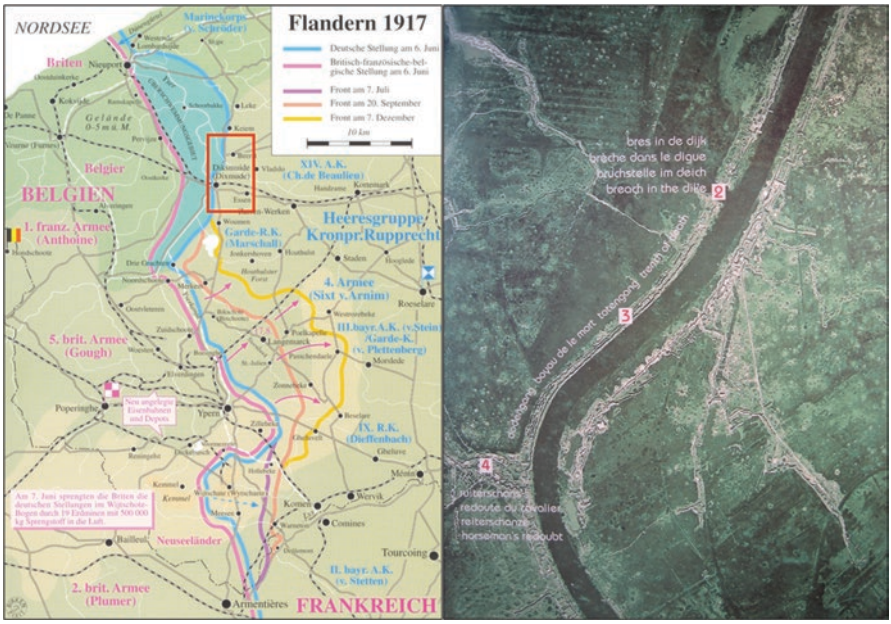

Fig. 5.8 Inundation area of the River Yser south of Nieuwpoort harbour (modified after Birken and Gerlach 2002, left; courtesy of Philathek publishers). Trenches located at both sides of the River Yser north of Diksmuide (right; panel exposed at Dodengang museum with "trench of death"; photo taken by Reinhard Mang, 5 July 2006)

group was composed of six military geology units which provided both expertises on flooding and a military geology atlas of Flanders (Fig. 5.8).

Detailed geologic maps are available as reprints at the geological survey in Brussels. Formations in Flanders are termed after sites situated in Belgium (e.g., Yper and Mont Panisel, near Mons). Consisting of mostly sand and clay, the formations were a large factor in the success of trenching for simple geologic reasons: clay is more or less impermeable, stopping the flow of water. Thus, overlying permeable sands act as an aquifer, and therefore – basically – trenches in the clay were wet, whereas trenches in the sand were dry (Fig. 5.9).

The valleys south of Ypres incise the Tertiary and Quaternary formations about 50 metres above sea level. This geologic situation was quite complicated because the Ypres Formation and the overlying Paniselian Formation comprised several aquifers, which considerably complicated mining activities (Fig. 5.10). From March 1916 the British army started a mining attack along the Messines–Wytschaete Ridge. Following the advice of their military geologists to dig trenches with adequate drainage, British miners started from the valley floors horizontally in the dry Ypres Clay and covered distances of more than 5400 m. Doyle (1998) and Doyle

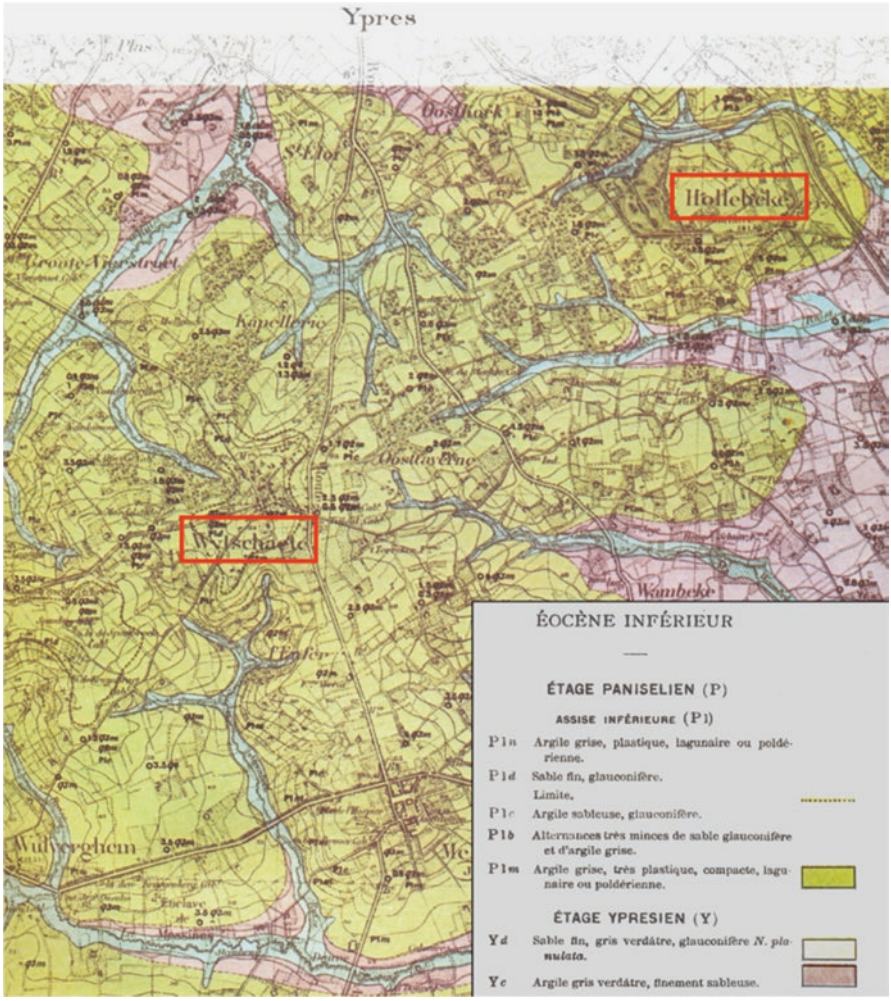

Fig. 5.9 Section of the Belgian geological map at original scale 1:40,000, sheet Neuve–Église–Messines (Institut cartographique militaire 1900), with legend of marine formations of Lower Eocene age. Red rectangles mark the important localities Wytschaete and Hollebeke south of Ypres

et al. (2000) presented examples of good and poor trenches and dugouts on the Western Front in relation to the underlying geology. Good positions would be well drained and dry, whereas poor positions would be liable to flooding through inadequate drainage or water seepage.

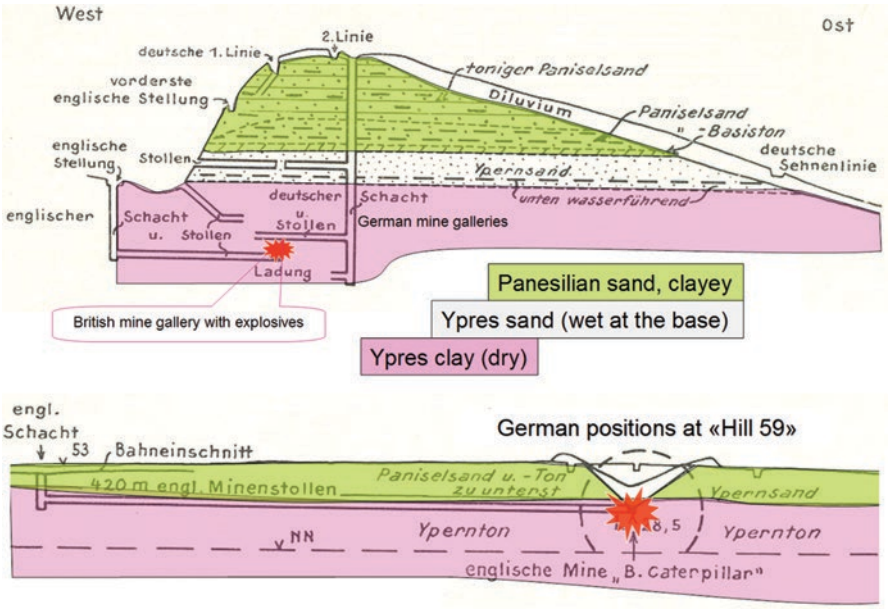

Fig. 5.10 Schematic geologic sections across the Messines–Wytschaete Ridge in 1917 (above). The German mine galleries were cut into the sand and clayey sand of the Paniselian Formation, whereas the British mine galleries were cut into the underlying dry Ypres Clay. The "Caterpillar Crater" at Hill 59, northeast of Wytschaete, resulted from the explosion of 31 tons of explosives. (Modified after Bülow et al. 1938)

Along the Messines–Wytschaete Ridge, a total of 19 galleries were cut into the Ypres Clay, far below the German positions (Oldham 2003). Dr. Walter Kranz reported that the German troops at that time disregarded the advice of the German war geologists who tried to explain the advantages and disadvantages of the mining situation in detail (Bülow et al. 1938, p. 69; see Fig. 5.11, this paper). Finally, Wytschaete has become a synonym for the purposeful, simultaneous blasting of 500 tons of explosives in 19 mines of the Battle of Messines on June 7, 1917. Aerial reconnaissance flights clearly reveal the damage caused by artillery and gallery explosions. Lying in what is today a recreational park, the Caterpillar Crater is situated opposite Hill 60 at an altitude of 60 m above sea level (Fig. 5.12).

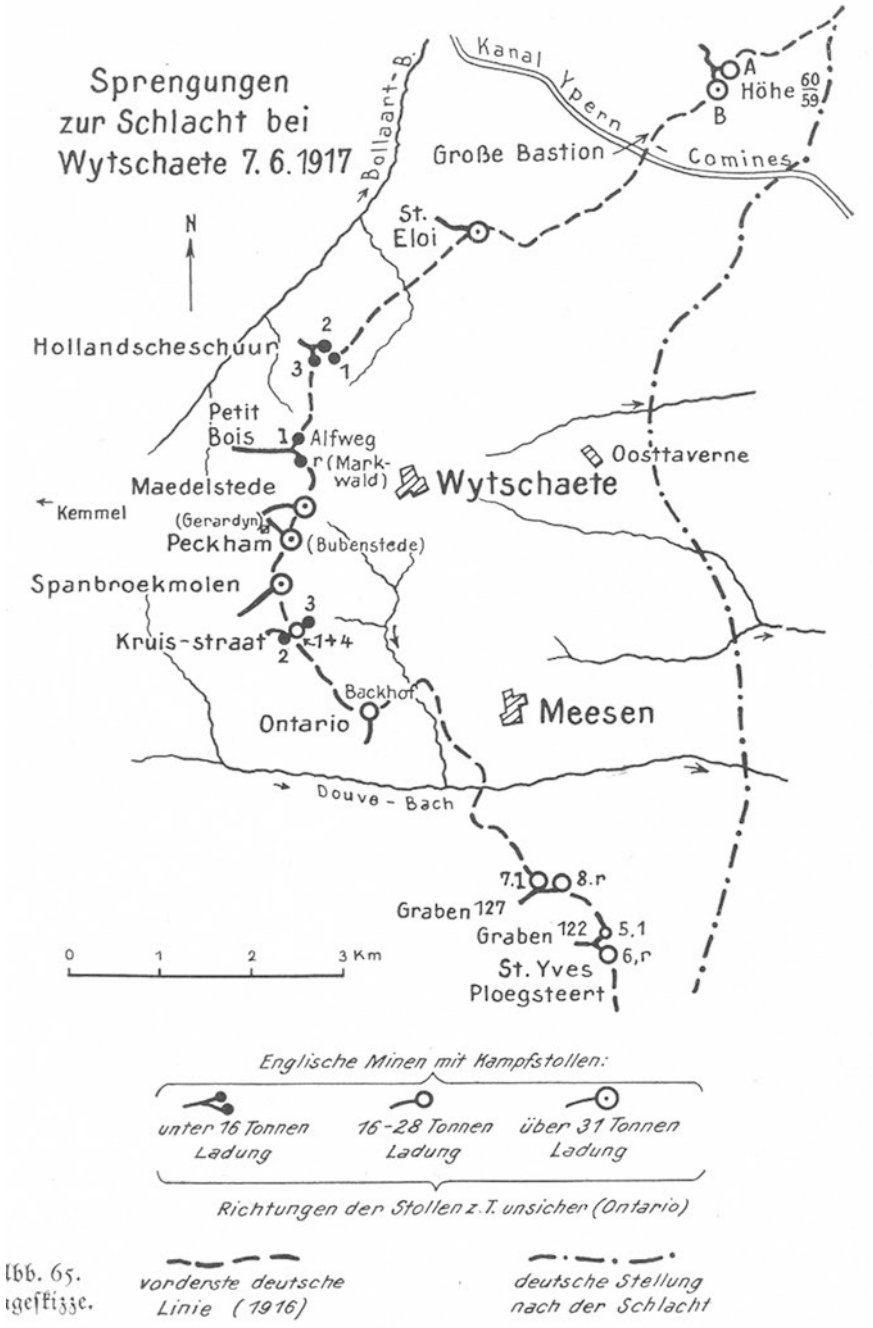

Fig. 5.11 Sketch of the German positions and mines blown up at the battle of Wytschaete on June 7, 1917. Legend for British mines and mine galleries ("Englische Minen mit Kampfstollen"): black dots, mines with less than 16 tons of explosives; white circle, mines with 16–28 tons; white circle with centre point, mines exceeding 31 tons of explosives. "Hill 59" and "Hill 60" are located northeast of Wytschaete (Bülow et al. 1938, see Cave 2004)

Fig. 5.12 Comparison between British trench maps and recent coloured orthophoto of the "Caterpillar Crater" near Hollebeke south of Ypres, presented at Flanders Fields Museum, Ypres (above), and present landscape with the "Caterpillar Crater lake". (Below; photos taken by Reinhard Mang, 30 June 2006)

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References

Birken, A., & Gerlach, H. H. (2002). *Atlas und Lexikon zum Ersten Weltkrieg. I Karten* (p. 114). Hannover: Philathek-Verlag.

Cave, N. (2004). *Battleground Europe, Ypres: Hill 60* (p. 160). Barnsley, South Yorkshire: Leo Cooper.

Chasseaud, P. (2002). British, French and German mapping and survey on the Western front in the first world war. In P. Doyle & M. R. Bennett (Eds.), *Fields of battle – Terrain in military history, The GeoJournal Library 64* (pp. 171–204). Dordrecht: Kluwer Academic Publishers.

Chef des Kriegs-Vermessungs-Wesens. (Hrsg.). (1918). *Kriegsgeologie*. Druckerei des General-Gouvernements in Belgien, Brüssel, p. 78.

Doyle, P. (1998). *Geology of the Western front, 1914–1918. Geologists´ Association Guide 61* (p. 79). London: The Geologists´ Association.

Doyle, P. (2000). A field guide to the geology of the British sector of the Western Front, 1914–18. In E. P. F. Rose & C. P. Nathanail (Eds.), *Geology and warfare: Examples of the influence of terrain and geologists on military operations* (pp. 381–412). London: The Geological Society of London.

Doyle, P., Matthew, R. B., & Cocks, F. M. (2000). Geology and warfare on the British sector of the Western Front 1914–18. In E. P. F. Rose & C. P. Nathanail (Eds.), *Geology and warfare: Examples of the influence of terrain and geologists on military operations* (pp. 179–235). London: The Geological Society of London.

Doyle, P., Bennett, M. R., Macleod, R., & Mackay, L. (2002). Terrain and the Messines Ridge, Belgium, 1914–1818. In P. Doyle & M. R. Bennett (Eds.), *Fields of battle – Terrain in military history, The GeoJournal Library 64* (pp. 205–224). Dordrecht: Kluwer Academic Publishers.

Häusler, H. (2000). *Die Österreichische und Deutsche Kriegsgeologie 1914–1918. Informationen des Militärischen Geo-Dienstes, 75* (p. 161). Wien: Institut für Militärisches Geowesen.

Institut cartographique militaire. (1900). Carte géologique de la Belgique, 1:40.000, no. 95, Neuve-Église-Messines (reprint), Brussels.

Keller, G. (1936). Die geologischen Vorraussetzungen für den Minenkrieg im Wytschaetebogen. *Zentralbl Min Geol Pal, 1936B*, 235–242.

Klauer, M. (2004). *Militärgeschichtlicher Reiseführer zu den Schlachtfeldern des Ersten Weltkrieges in Flandern und Nordfrankreich* (p. 191). Velbert: Gesellschaft für Druck und Veredelung mbH.

Kranz, W. (1935). Minierkampf und Kriegsgeologie im Wytschaetebogen. *Vierteljahreshefte für Pioniere, 2*, 166–181.

Kranz, W. (1936a). Allgemeine Lehren aus den Minierkämpfen im Weltkrieg: Die Wytschaete-Sprengungen bei Hollandscheschuur und Petit Bois; taktische Wirkungen der Sprengungen am 7. Juni 1917. *Sonderbeilage zu* "*Deutsche Wehr*", *40*(31), 1–6.

Kranz, W. (1936b). Kämpfe im Wytschaetebogen und Kriegsgeologie. *Nachrichten aus Württemberg, 209*.

Kranz, W. (1937). Der Kampf um Wytschaete. *Deutsche Pionier-Zeitung, 14*, 13.

Kraus, E. (1918). Geologische und kriegsgeologische Übersicht über das Gebiet der Armeeabteilung B. *Vermessungsabteilung, 13*, 17.

Kraus, E. (Ed.). (1919). *Die Kriegsgeologie des Oberelsaß* (p. 176). Vermessungsabteilung 13: Berlin.

Kraus, E., & Klüpfel, W. (1925). Lothringen. In J. Wilser (Ed.), *Die Kriegsschauplätze 1914–1918 geologisch dargestellt* (Vol. 2, p. 212). Berlin: Borntraeger.

Kraus, E., & Wagner, W. (1924). Elsass. In J. Wilser (Ed.), *Die Kriegsschauplätze 1914–1918 geologisch dargestellt* (Vol. 1, p. 154). Berlin: Borntraeger.
Lais, R. (1925). Zwischen Maas und Mosel. In J. Wilser (Ed.), *Die Kriegsschauplätze 1914–1918 geologisch dargestellt* (Vol. 3, p. 116). Berlin: Borntraeger.
Oldham, P. (2003). *Battleground Europe, Ypres: Messines Ridge; Messines – Wytschaete – St. Eloi* (p. 144). Barnsley, South Yorkshire: Leo Cooper.
Rose, E. P. F., Häusler, H., & Willig, D. (2000). Comparison of British and German military applications of geology in world war. In E. P. F. Rose & C. P. Nathanail (Eds.), *Geology and warfare: Examples of the influence of terrain and geologists on military operations* (pp. 107–140). London: Geological Society.
Sturm, F. (1923). Vor Verdun. In J. Wilser (Ed.), *Die Kriegsschauplätze 1914–1918 geologisch dargestellt* (Vol. 4, p. 44). Berlin: Borntraeger.
von Bülow, K., Kranz, W., Sonne, E., Burre, O., & Dienemann, W. (1938). *Wehrgeologie* (p. 164). Leipzig: Quelle & Meyer.
Wilser, J. (1927). Die Kriegsschauplätze 1914–18 geologisch dargestellt. *Forschungen und Fortschritte, 3*, 77.

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