GUIDEBOOK

Geology and wines of the Kraków area – regional rebirth of vineyards as a result of climate change

Guide to field trip A7 • 22 June 2015

Joachim Szulc

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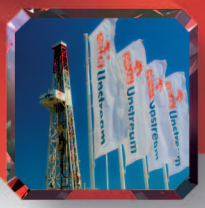

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Geology and wines of the Kraków area – regional rebirth of vineyards as a result of climate change

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Route (Fig. 1): From Kraków we drive NW by road 94 to Jerzmanowice, then we turm right onto a local road to Ojców. From Ojców north along the Prądnik Valley to **Hercules' Club (stop A7.1)** near Royal Castle at Pieskowa Skała, and back along the valley to **Maszyce Cave (stop A7.2)**. Then to **Krokoszówka Górska Vineyard (stop A7.3)** at Smardzowice (the part of the road south from Ojców is closed for public traffic; we will drive with a permission). After wine testing and lunch in the vineyard we follow road 794 south to a roadside cliff at **Januszowice (stop A7. 4)**. Then west by a local road through Giebułtów to Modlnica and then south by road 94 to motorway 7 leaving it at Węzeł Mirowski following signs "Kraków – centrum". At the end of the slip road we turn right to **Piekary (stop A7.4)**. From Piekary by Mirowska Street to **Srebrna Góra Vineyard in Bielany (stop A7.5)**. After wine testing we return to Kraków centre.

Fig. 1. Route map of field trip A7.

Introduction to the trip

Joachim Szulc

Geology of the Kraków area

The Kraków region is situated within the boundary zone between two collided microplates: the Małopolska Terrain (called also Małopolska Massif) and the Brunovistulian Terrain (called also Moravo-Silesian Block). The first one docked from the west to the major Baltic continental land mass (Fig. 2) in middle Cambrian times. In turn, the Brunovistulian microplate accreted to Małopolska Massif in early Devonian (Nawrocki & Poprawa, 2006). The resulted, SE-NW trending, collision line makes one of the most important master fault in Central Europe, stretching from Kraków to Hamburg in Germany (Fig. 3).

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Guidebook is available online at www.ing.uj.edu.pl/ims2015

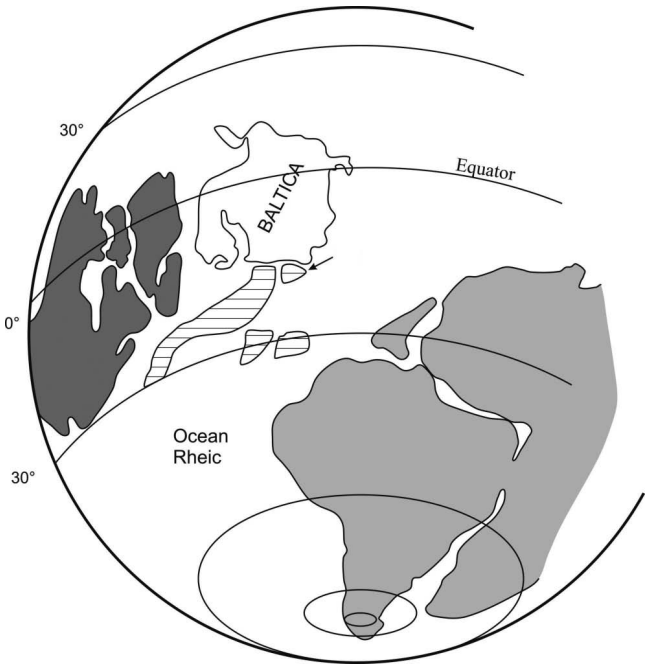

Fig. 2. Paleozoic position of the Małopolska and Brunovistulian microplates (arrow).

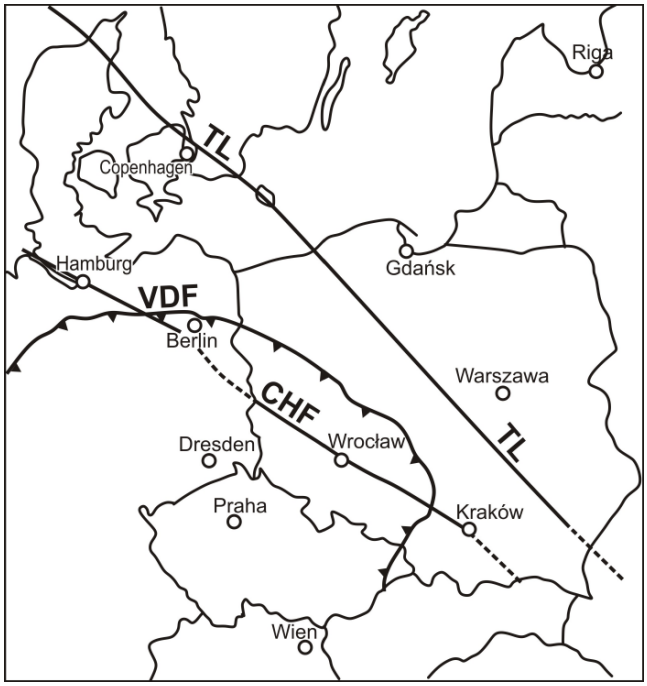

Fig. 3. Main tectonic lineaments of Central Europe. TL – Teiseyere –Tornquist Line, CHF – Cracow-Hamburg Fault, VDF – Variscan front (from Szulc, 2000).

The basic structural framework of Southern Poland was established during Hercynian orogeny, when the Kraków area became far eastern foreland of the Hercynian mountain range.

Paleozoic

The oldest rocks cropping out in the Kraków vicinity are Middle Devonian-Lower Carboniferous, shallow water, platform carbonates (Fig.4A), rich in benthic fauna: stromatoporoids, corals, brachiopods and bryozoans. Hercynian orogeny, that began at the Early/Late Carboniferous break, resulted in eventual closing of the marine basins and in replacement of carbonate sediments by brackish and continental, coal-bearing, Upper Carboniferous clastics.

The intensive Hercynian tectonism involved also magmatic activity in the region manifested chiefly by intrusive rocks. Most of the igneous rocks are acid and display chemical composition typical for intracontinental magmatic provenance.

The tectonic and magmatic activity continued also in early Permian times. The tectonic regime changed however from orthogonal W–E oriented compression into transtensional rotation. The strike-slip movement at the NE margin of the Upper Silesian Basin resulted in development of narrow (<15 km) trough structure (Sławków Graben). The faults bounding the graben, reached deep enough to enable magma to migrate and form intrusive and volcanic rocks (Fig. 4 A)

The graben was filled with continental molasse deposits composed of fanglomerates (Fig. 4B) volcaniclastics, playa redbeds with evaporites (Fig. 4C) and travertines.

Mesozoic

After the Hercynian orogeny, the discussed region was subjected to denudation that continued throughout the early Triassic. Thin (up to several meters) Buntsandstein continental clastics represent this period.

By the end of the early Triassic, the Silesian-Kraków region was inundated by Röt transgression, which gave way to the subsequent, very pronounced Muschelkalk transgression in the middle Triassic (Fig. 6A). The Silesian-Kraków area formed a treshold block, that divided the Tethys Ocean from the epicontinental Germanic Basin (Fig.5). According to dominating open marine fauna (including coral-sponge reefs), the visited region should be recognized as an integral part of the Tethys Ocean.

During late Triassic times, the Silesian-Kraków region was affected by eo-Cimmerian tectonic movements that caused its emersion. The Keuper and Rhaetian are developed mostly in continental clastic (fluvial) and carbonate (palustrine) facies.

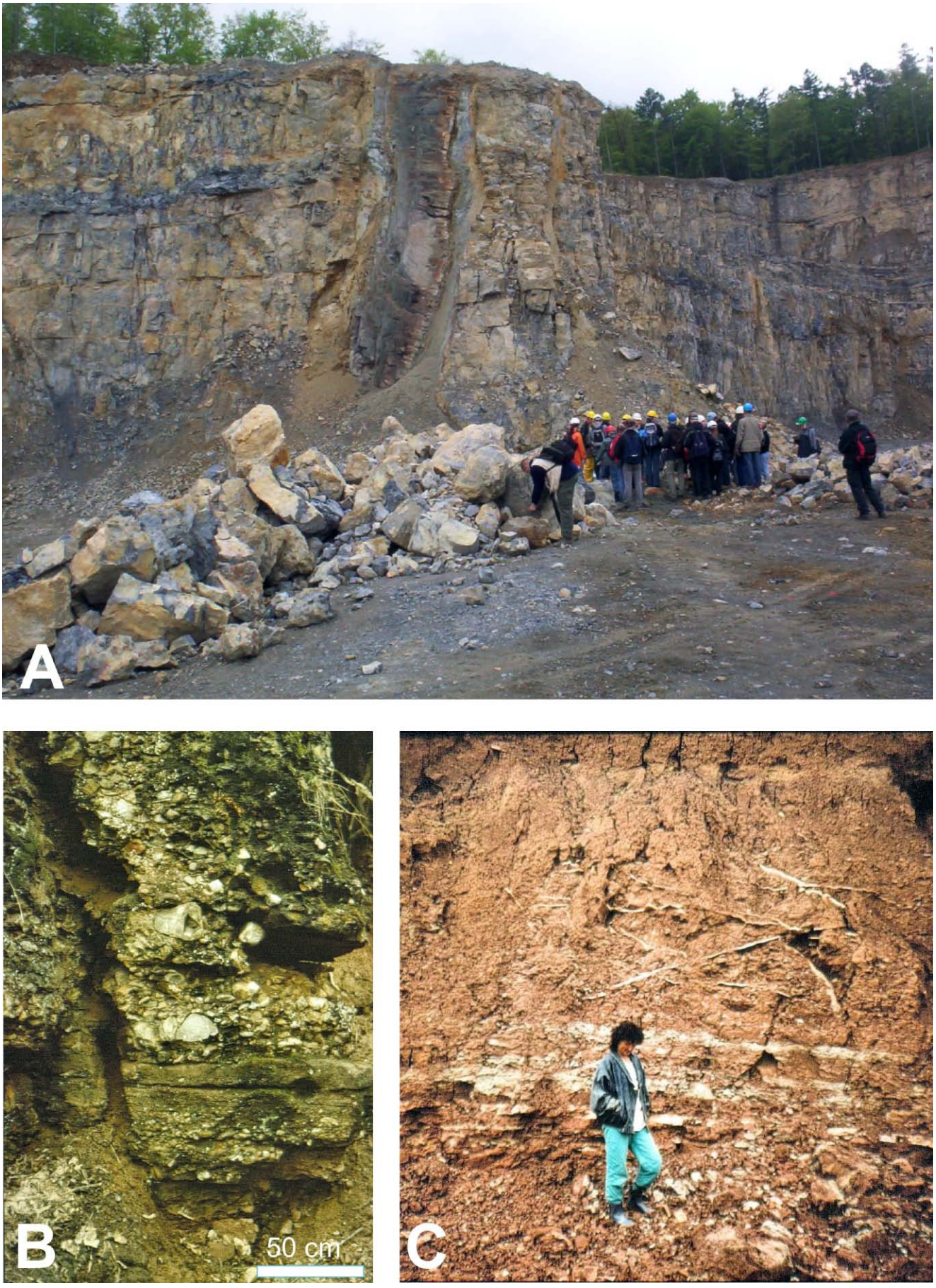

Fig. 4. Chosen Paleozoic rocks of the Cracow Upland: **A.** Givetian dolomites dissected by a Lower Permian intrusive dyke. Dubie quarry. **B.** Lower Permian fanglomerates. Karniowice. **C.** Lower Permian playa redbeds with gypsum veins. Sławków claypit.

The eo-Cimmerian tectonics discharged Pb-Zn – bearing hydrothermal fluids and provided tectono-karstic conduits for their migration. The resulted Mississippi Valley-type ores have been exploited here since Mediaeval times.

Continental environments persisted until the early Jurassic and the next transgression came only in middle Jurassic.

The transgression reached its maximum in Callovian-Oxfordian interval, when entire central Europe was flooded by shallow sea. In this time, carbonate sedimentation dominated in Kraków region (Fig. 6 B),. The carbonate facies of the Oxfordian are very similar to those from the Jura Mountains and southern Germany and comprise sponge-microbial bioherms, and detrital cherty limestones, and marls deposited between the bioherms (Stop A 7.5) (Fig. 6 C-D, Fig. 7).

Tectonic movements that took place in early Cretaceous caused upwarping of the Kraków region and resulted in its emersion. Nonetheless the global late Cretaceous transgression (Cenomanian-Senonian) overlapped also the southern Poland platform. During maximum phase of the transgression glauconitic marls and limestones deposited.

Because of the tectonic movements related to closing of the nearby Carpathian basins, and because of eustatic

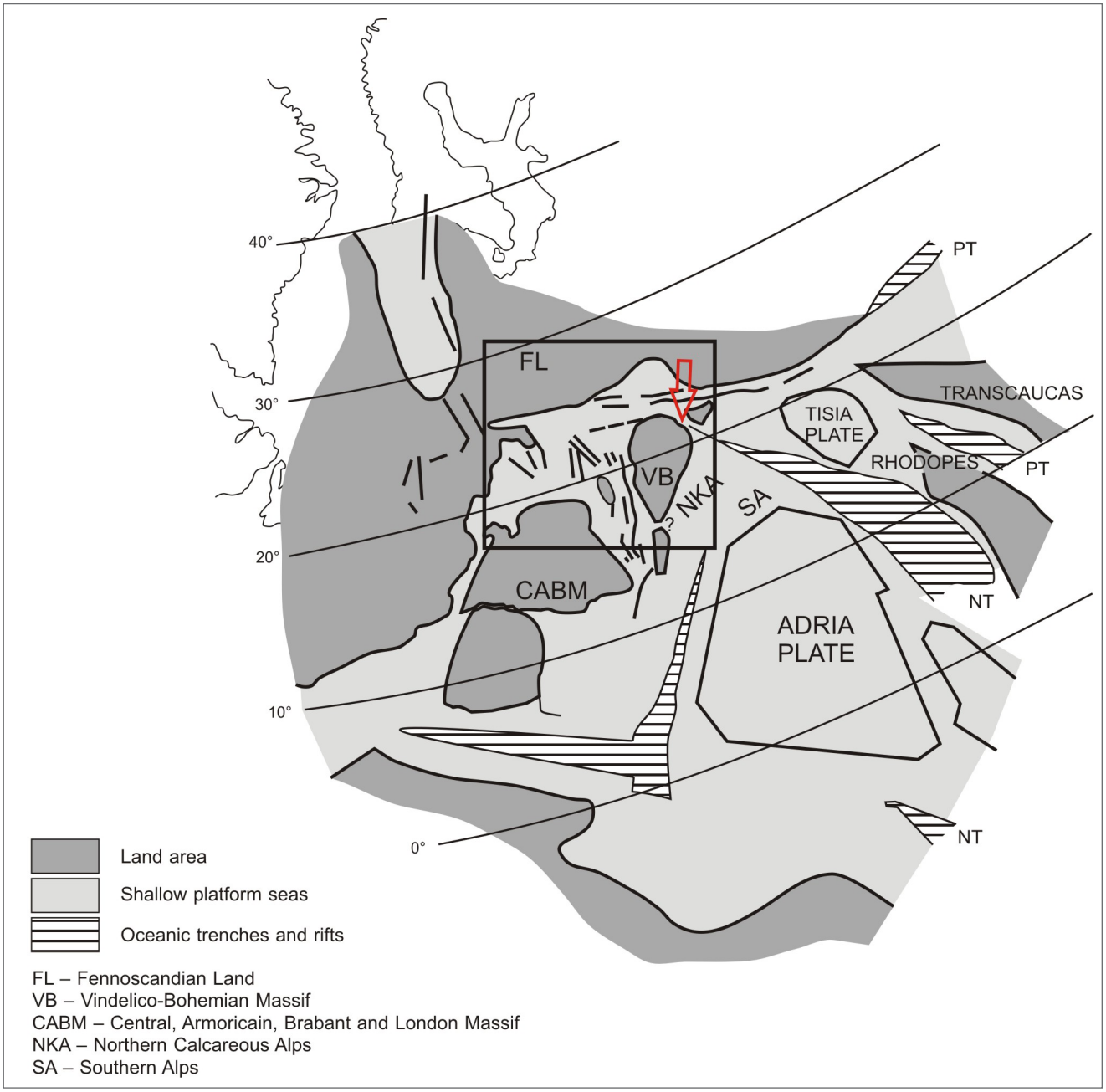

Fig. 5. Paleogeography of the Western Tethys and Peritethys in middle Triassisc. Arrow indicates position of the Kraków-Silesian region (from Szulc, 2000).

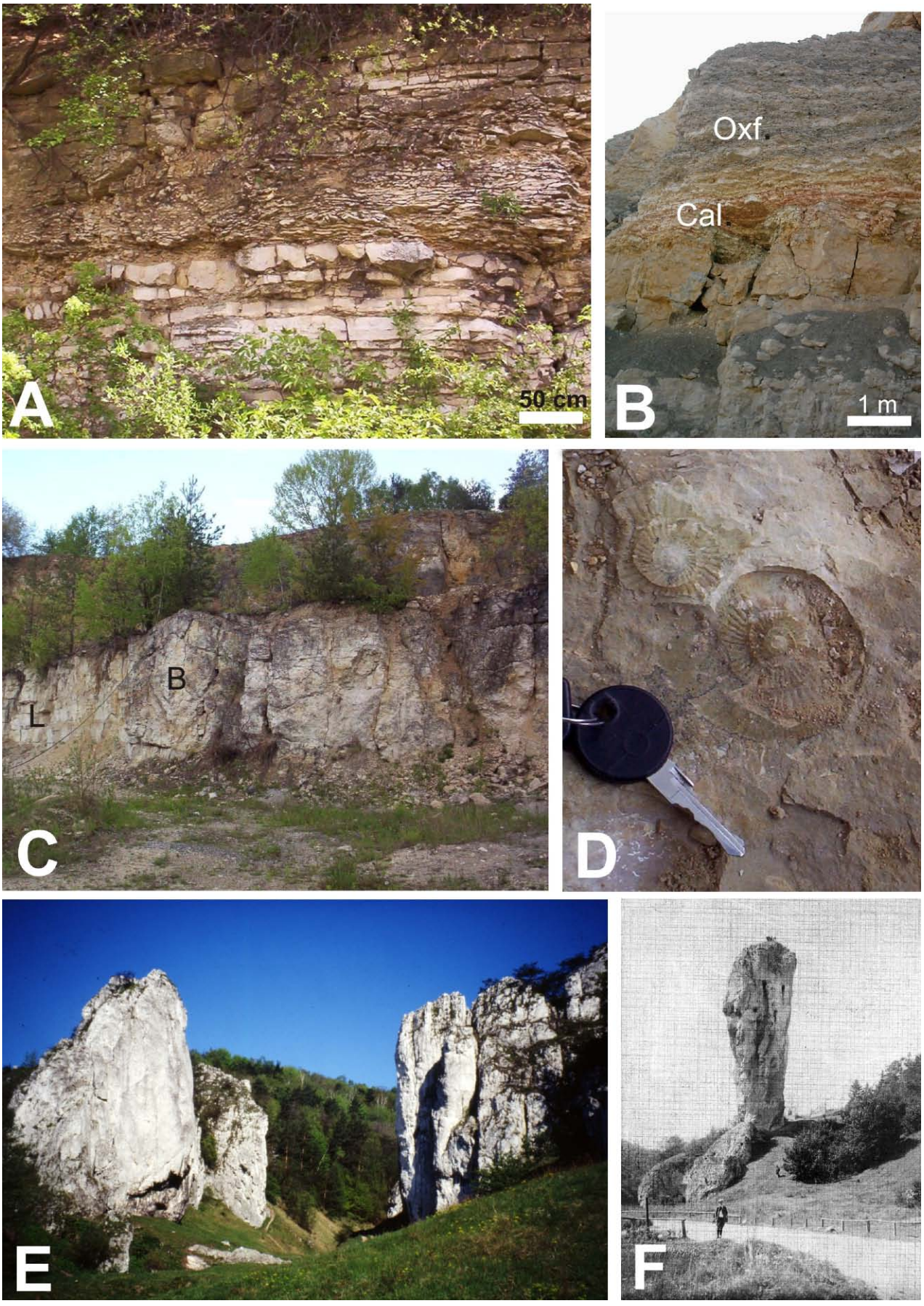

Fig. 6. Chosen Mesozoic rocks of the Cracow Upland. **A** – Middle Triassic Muschelkalk limestones. Libiąż quarry; **B** – Callovian-Oxfordian transgressive succession in Zalas quarry; **C** – Oxfordian biohermal (B) and bedded limestone facies. Młynka quarry; **D** – Oxfordian platy limestones with ammonites. **E** – Cliffs built of Upper Jurassic massive limestones. Bolechowicka Valley (photograph by Michał Gradziński). **G** – Hercules' Club in Ojców National Park. Postcard from the 19th century.

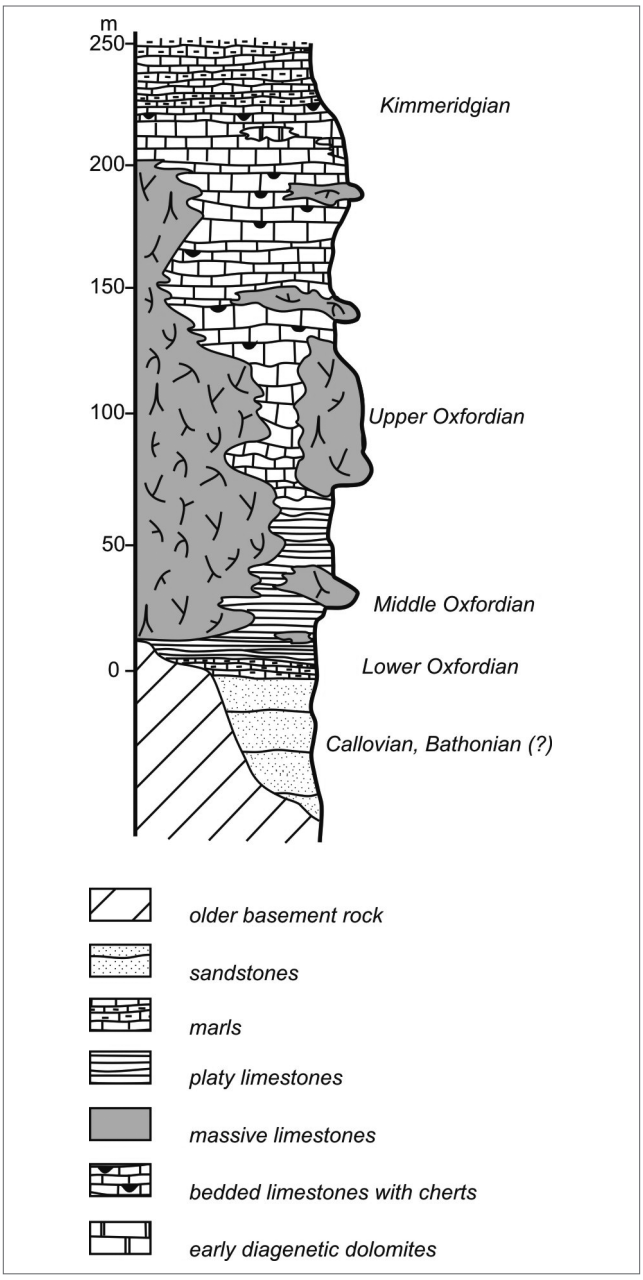

Fig. 7. Geological section of the Jurassic of the Kraków region. After Matyszkiewicz and Krajewski, 2007 (simplified).

fluctuations, the Upper Cretaceous succession of the Silesian-Kraków area displays several stratigraphic gaps and disconformities (Stop A 7.4).

Cenozoic

The Alpine orogeny and closing of the Carpathian basins caused uplift of the Kraków-Silesian region probably already in latest Cretaceous. After emersion the carbonate rocks, that dominate in the region underwent vigorous karstification. Extensive underground and surficial karst forms developed (Stop A 7.1 and 2). The Kraków Upland abounds in caves and sinkholes. These forms are believed to be founded in Paleogene though their exact age is not established because of the lack of stratigraphical indicators and because of polyphase history of chemical denudation.

After Paleogene emersion, the Miocene transgression of the remnant Carpathian basin (Paratethys Sea) (Fig. 8) encompassed the Kraków region. In the shallow perilittoral zone marls with bivalves (oysters) deposited. In the basin centre, saline brine concentrated and halite precipitated. It has been exploited in the famous Wieliczka Salt Mine near Kraków. The coastal limestone cliffs were encrusted by caliche coatings.

The present tectonic and topographic pattern of the Kraków environs was shaped in Miocene time. The Kraków area was dissected into several horsts and grabens that strike more or less parallely to the Carpathian front (Figs. 9-10). The faults resulted from breaking of the rigid Kraków platform when the Carpathian nappes were emplaced from the south.

Pleistocene ice lobes invaded the Kraków Upland once. The melted glaciers left tills, glaciofluvial sands and glaciolacustrine muds and clays. The last glaciation (Vistulian) did not reach the visited area, however it provided loess material, that accumulated on slopes creating a several metres-thick cover on the older rocks.

The Pleistocene deposits were partly eroded in Holocene so the older topography has been exhumed. In spring zones and river valleys, peats and travertines accumulated.

The past and present of vine in Kraków region

First historical annotations about winery of Kraków come from a 12th century travel chronicle, by Al-Idrisi – a Sicilian-Arab geographer, who mentioned several vineyards from the Kraków area (Lewicki, 1945). According to archeological studies, the royal Wawel hill was overgrown by *Vitis* plants on its SW site as early as the 10th century. This vine cultivation was certainly introduced to Kraków by Czech monarchs ruling in this period the Malopolska region.

The other important center of wine production was the Benedictine Abbey of Tyniec (some 10 km SW from Kraków downtown), founded in the 11th century by monks coming here from Lower Lotharingia. Vine cultivation and wine production persisted until the 18th century in the entire Kraków region. Gradual decline of vine cultivation is observed since the 17th century as a

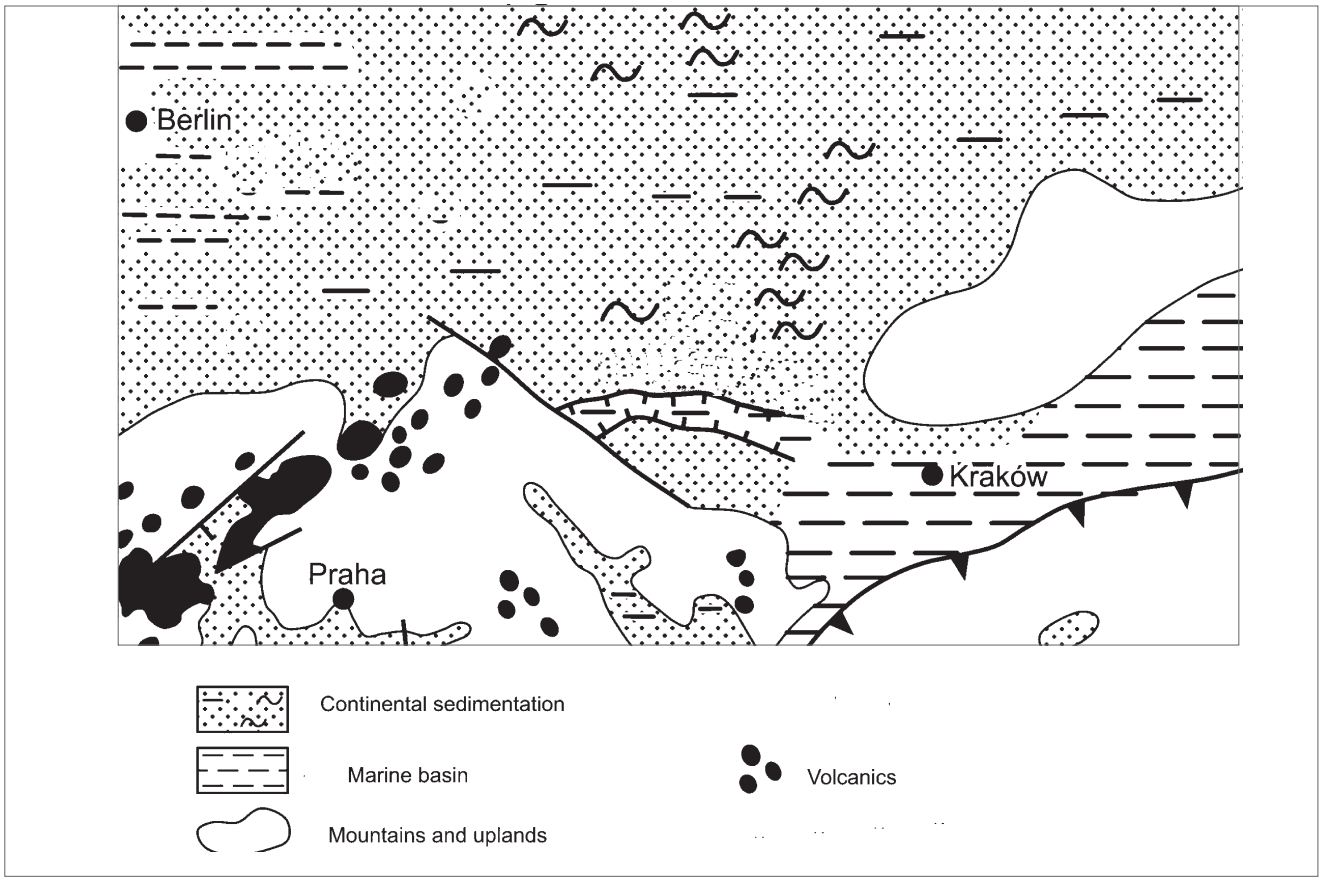

Fig. 8. Paleogeography of southern Poland in Miocene time.

combined effect of climate cooling and political changes in central Europe. Poland lost its power position and was divided in the 18th century between three neighbors – Prussia, Russia and Austria. Kraków became a part of Austrian monarchy, which beside Austria, included Czech and Hungary territories, i.e. countries much more predisposed for vine cultivation. This led to collapse of wine production in Kraków area. Nonetheless some small vine refuges persisted in Kraków - among others on the Wawel hill and in Camaldolese Hermitage on the Bielany hill (Stop. A 7.)

Vine revival in Kraków region, and in entire southern Poland, began around 2000, as some wineries originated in Kraków vicinity. Wineries have been also supported with professional consulting aid by Polish Institute of Vine and Wine, founded in Kraków in 2003. Concurrent climatic amelioration (in particular milder winters) favoured development of this branch of economical activity in the region.

Average annual temperature reaches some 8.5°C while the average winter temperature is around 0 °C in Kraków Town, and even cooler in higher situated vineyards. Therefore the winemakers cultivate mostly frost-

Fig. 9. Geological map of the Kraków region (after Gradziński, 1985) and location of the visited vineyards: KG - Krokoszówka Górska, SG – Srebrna Góra).

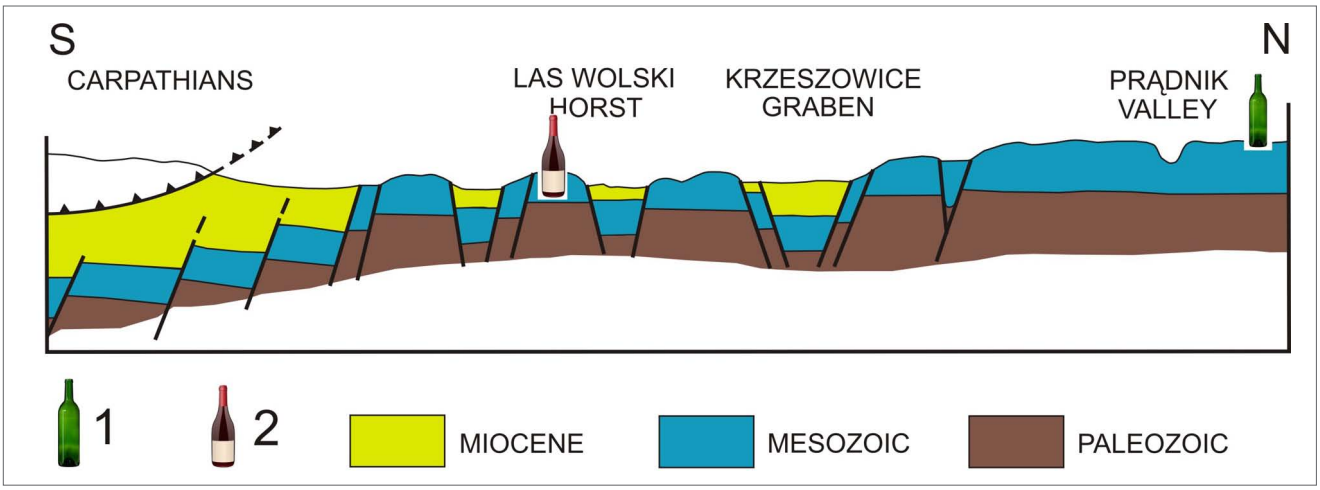

Fig. 10. N-S geological section of the Kraków region (after Gradziński, 1985, simplified) with marked positions (bottles) of the visited vineyards – 1. Krokoszówka Górska, 2 – Srebrna Góra.

resistant (able to withstand temperatures as low as minus 30 °C !) hybrids of the Vitis vinifera species. This implies shorter vine-growing period and earlier ripening and maturation. of grapes. Cooler climate forces the grapes to ripen earlier, which produces a fresher and more acidic harvest. Another handicap for viticulture in southern Poland is the rainfall regime with a maximum in July, what promotes fungal diseases and berry splitting. Sunshine amount ranges between 1200 and 1800 hrs/year (see: http://www.klimat.geo.uj.edu.pl/tematyczne/klimatkrakowa/index2.htm).

The cultivated vine hybrids (Polish spelling is used herein for names of vine varieties) come mostly from German oenological institutes and comprise, among others, solaris, johanniter, hibernal, seyval blanc, sibera, bianca, phoenix, muscaris – for white wines, and regent, rondo, leon millot, marechal foch, cabernet cortis, cabernet carol, rössler, rathay and bolero – for red wines. Subordinate role play "noble species – chardonnay, pinot gris, traminer, riesling, zweigelt, pinot noir or dornfelder.

Stop descriptions

A7.1 Hercules Club (Maczuga Herkulesa) in Ojców National Park

(50°24′28″ N; 19°73′00″ E)

Leader: Joachim Szulc

The scenic Prądnik valley is incised in Upper Jurassic carbonate rocks, developed in three facies. The first one, massive biolithic limestones, is built of sponges and microbial bioherms that pass laterally through thick-bedded limestones into platy marls. Such a facies pattern resulted in present-day topography: the massive, erosion-resistant biohermal and thick-bedded limestones are exposed in high cliffs (Fig. 6E) and isolated towers – like the Hercules Club (Fig. 6F) – a topographical trade mark of the region, while the adjoining soft marls underwent substantial erosion, giving way to depressions. Chemical denudation has been enabled by post-sedimentary tectonic disturbances.

A7.2 Maszycka Cave

(50°17′84″ N; 19°84′49″ E)

Leader: Joachim Szulc

Maszycka Cave is situated on the left slope of the Prądnik Valley, close to Maszyce village. The relatively small (6 m wide and 3 m high)and inconspicuous cave is one of the most important archeological sites in Poland. During its long exploration that started already in 1883 with excavation by Godfryd Ossowski (Fig. 11), numerous Palaeolithic and Neolithic artefacts have been found here (Ossowski, 1885; Kozłowski et al., 2012). The most interesting are bone tools (including points, navettes and decorated antler (Fig. 12) and other items from late Palaeolithic i.e. from the Late Glacial, as evidenced by their radiometric age of ca. 15 ky BP. The tools represent the Magdalenian culture showing close connections to the French Middle Magdalenian. Other intriguing Palaeolithic finding are human bones of 16 people, displaying traces of cannibalistic practices.

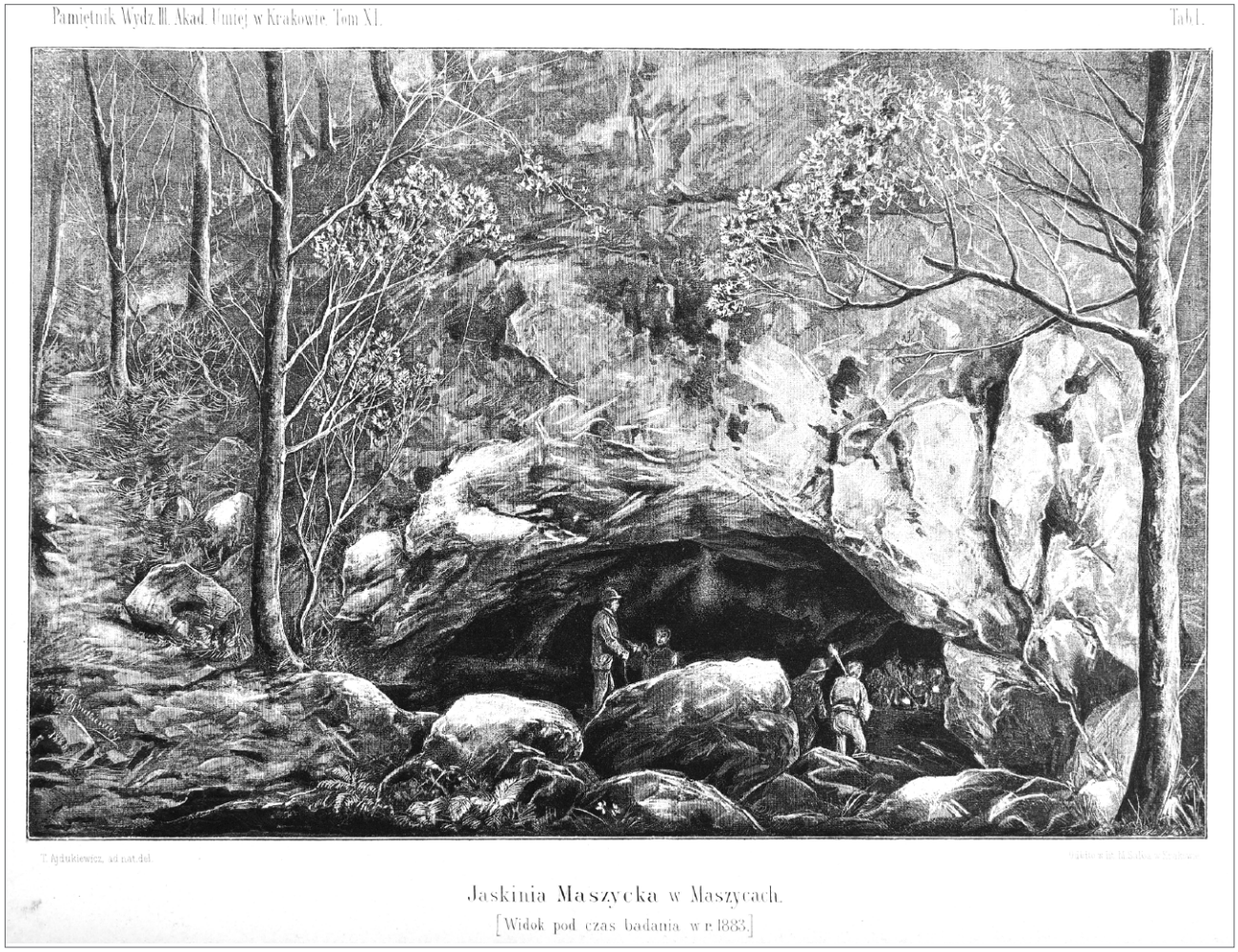

Fig. 11. Exploration of Maszycka Cave in 1883. From Ossowski, 1885.

Fig. 12. Paleolithic bone tools from Maszycka Cave. From Ossowski, 1885.

A7.3 Krokoszówka Górska vineyard

(50°19′20″ N, 19°86′57″ E)

Leaders: Marek Górski[1], Joachim Szulc

[1]Vineyard Krokoszówka Górska
(poczta@krokoszowka-gorska.pl)

The small (ca. 1 hectare) vineyard (Fig. 13) lies at altitude of some 400 m a.s.l. and is founded on clayey soils developed on Quaternary loess and Upper Jurassic limestones. The soil is rich in P, Mg and K elements. Average annual temperature reaches some 6°C, i.e. 2°C less than in Kraków (altitude effect). Harvest time falls on late September – early October. Temperatures in winter average around 0°C. The cultivated grapes are hybrids – leon millot, marechal foch, swenson red, kristaly, jutrzenka (local hybrid), seyval blanc, solaris, regent and chardonnay.

The wines are well structured. Layers of lilac, blackberry, blueberry and cherry fruits with slight tobacco hints are distinguishing features. Detailed information on the winery at: /www.krokoszowka-gorska.pl/kontakt.html

A7.4 Januszowice roadcut

(50°14′35″ N, 19°89′65″ E)

Leader: Joachim Szulc

Upper Jurassic-Upper Cretacous disconformity. Abrasion surface cutting Upper Jurassic limestones and overlain by Turonian limestones.

A7.5 Piekary village

(50°01′72″ N, 19°79′50″ E)

Leader: Joachim Szulc

Exposure of Upper Oxfordian limestones in an abandoned quarry set in a small horst on the left bank of the Vistula river. The outcrop presents lateral transition between massive, biohermal limestones (in the southern part of the outcrop) and the bedded, chert-bearing limestones (in the northern part of the outcrop). On the opposite bank of the Vistula river stays the Benedictine Abbey at Tyniec – the 12th century centre of viniculture. The Abbey is built on another horst. The Vistula valley follows here a graben structure between the two horsts.

A7.6 Srebrna Góra vineyard

(50°02′44″ N, 19°50′28″E)

Leaders: Mirosław Jaxa Kwiatkowski[1], Joachim Szulc

[1]Vineyard Srebrna Góra, Kraków
(mjk@winnicasrebrnagora.pl)

The vineyard on the Bielany horst is the biggest one in southern Poland and occupies a territory of 12 hectares (Fig. 14 A). The hill is owned by Camaldolese monks who have cultivated vines (on a much smaller scale) from the 17th century up to recent times. From the hill, the tectonic framework of the Kraków region is clearly visible (Fig. 14 B).

Fig. 13. Krokoszówka Górska vineyard in Smardzowice and white wine label produced in the vineyard.

The horst is built of Oxfordian limestones giving way to calc-magnesian rendzina soils with varied humic components. Only the northern part of the vineyard is founded on glacial clays and sands.

Average annual temperature is around 8°C. The grapes are harvested from August (siegerrebe, solaris, acolon and rondo) to late October (riesling).

The cultivated grapes are hybrids – solaris, johanniter, hibernal, seyval blanc – for white wines, and regent, rondo, cabernet cortis – for red wines (Fig. 14 C-D). In contrast to other vineyards, the Srebrna Góra vineyard is experimenting with species of *Vitis vinifera* – chardonnay, riesling, pinot gris, traminer, auxerrois, siegerrebe and zweigelt, pinot noir and acolon.

Fig. 14. Srebrna Góra vinery and wines and other local wines. **A** – Bielany horst in Kraków with Camaldolese hermitage and Srebrna Góra vineyard (photograph by Łukasz Sakiewicz). **B** – View from the Bielany hill on the Vistula valley in Kraków and the front of Carpathians (in the background). **C–D** – Wines from the Srebrna Góra vineyard. **E–G** – Labels of wines from other vineyards in the Kraków region.

The white wines are fresh and display good concentration of fruit with refreshing acidity and aromas of flowers, white fruits and lemon. The red wines, first of all Pinot noir, are light bodied, subtle, earthy, with right acidity and aromas of dark fruits such as red currant and cherries.

Detailed information on the winery one may find at: www.winnicasrebrnagora.pl.

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