The development of modern map production: the example of topographic and orienteering maps

SDI DAYS ZAGREB, Croatia
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1st Regional INSPIRATION forum
4th NSDI INSPIRE DAY
8th Conference CARTOGRAPHY Geoinformation

Motivation of the paper (ICA-IOF)

- A similar paper was presented on the ICA History on Cartography workshop this summer in Budapest and Prof. Lapaine asked me to give a keynote presentation on o-maps.
- ICA: Secretary-General; IOF: Council member
- I have been practising orienteering for about 40 years (run in about twenty countries).
- I have already made some research (papers on all ICCs since 2001) on orienteering maps.
- Orienteering maps are not part of the „official" cartography in most of the countries, but definitely part of the cartographic heritage, part of the history of the 20th century cartography.
- About 25000 different orienteering maps are produced every year.

The first topographic maps

- The map series, Carte de Cassini was published in 1746-1789. This was the first accurate topographic map of an entire country, France (1:86400, 181 sheets).

Early topographic maps

- Maria Theresa, the ruler of the Habsburg dominions was the initiator of the **First Military Survey** (at a scale of 1:28800) at the end of the 18th century (finished by Joseph II).
- The regulation described the importance of surveying mostly as a military activity (to protect the country).
- It was the time when the emperor founded the Academy of Mining and Forestry (Berg-Schola) in Selmec (Banská Štiavnica, Slovakia), which is considered the first technical institute in the world. **Surveying** studies were also given in the institute.
- The maps of this survey are not comparable to recent topographic maps: the precision, the representation is acting on the contemporary mapping opportunities, but all cartographers of our region respect these works.

The First Military Survey

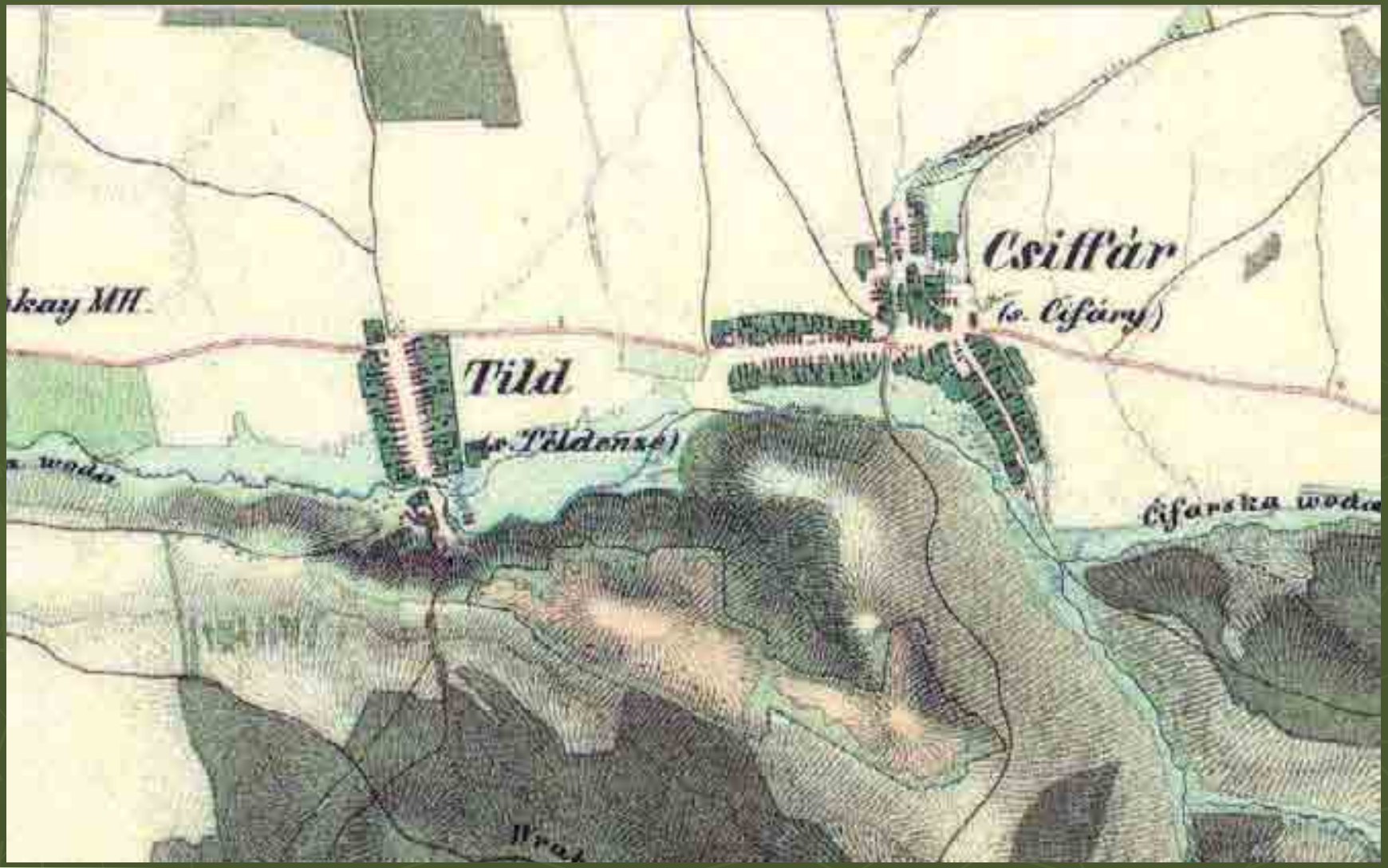
1763-87.

Early topographic maps

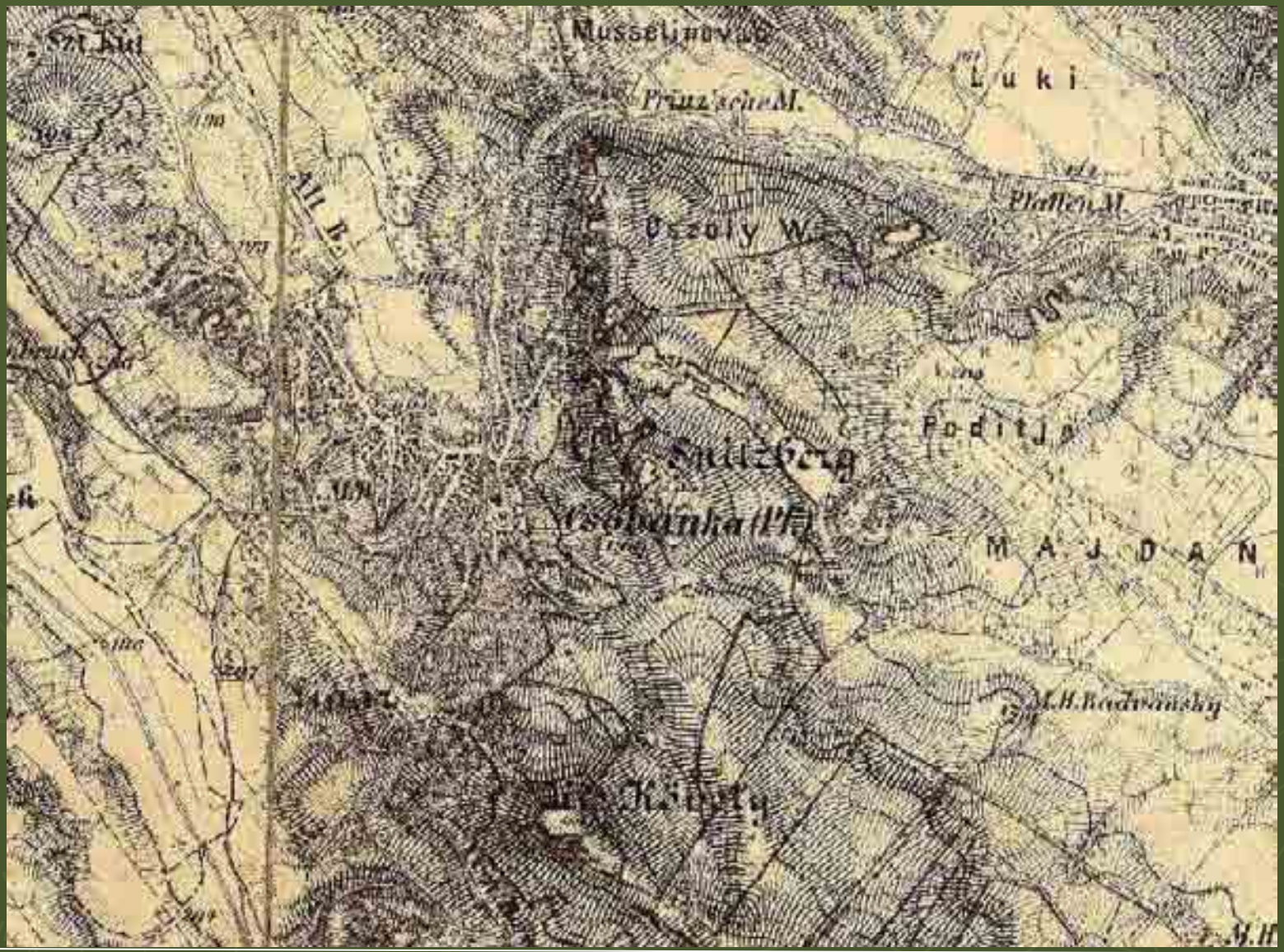
- The main shortcoming of the early topographic maps was the **general lack of elevation measurements**, other than a few spot elevations determined by measuring the variation in air pressure with altitude using a barometer, if there were such measurements at all or the relief description was simply **‘à la vue’**.
- Although this method of contour lines allowed the accurate depiction of the relief on a flat, two-dimensional map, it was not widely used until the mid-1800s mostly because of the lack of efficient measuring techniques.
- One of the first tourist maps was a map of the High Tatra Mountains made by a Swedish botanist, George Wahlenberg in the beginning of 19th century.

The Second Military Survey

1806-69.



The Third Military Survey



1869-84.

Back to nature

- The civilian interest in **sports**, including cross-country races became important at the time of **romanticism**, which was an intellectual and artistic movement that originated in the second half of the 18th century.
- Romanticism was also a reaction against the material changes in society, which accompanied the expanding **industrial capitalism**. According to the Romantics, the solution was **“back to nature”** because nature was seen as source of renewal.
- The traditional team sports are seen as originating from Europe, primarily England through the British Empire.
- Regardless of game origins, the Industrial Revolution and mass production brought **increased leisure**, which allowed more time to engage in playing or observing spectator sports, as well as less elitism in and **greater accessibility of sports** of many kinds.

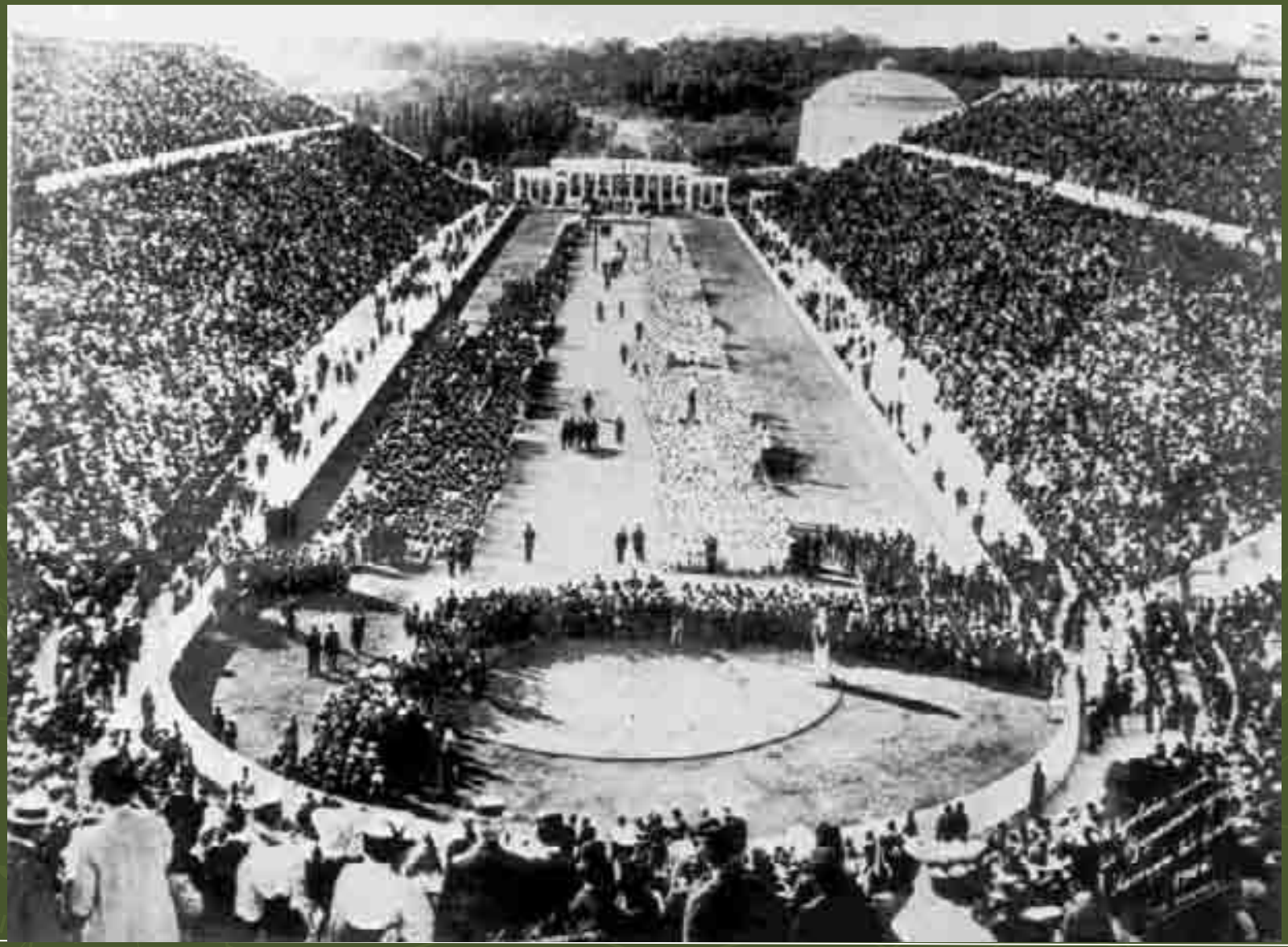
Back to nature

Caspar David Friedrich (1774–1840):
The wanderer above the sea of fog

Back to nature

- During the 18th century, several small-scale multi-sports festivals across Europe were organized (sometimes the term Olympian Games were used).
- In 1894, **Pierre de Coubertin** organized a congress in Paris to present his plans on the **Olympic Games** to representatives of sports societies from different countries. Congress members suggested holding the inaugural modern Olympic Games in 1896.
  - Athletics, cycling, fencing, gymnastics, shooting, swimming, tennis, weightlifting and wrestling were the sports of the first Olympic Games; rowing and yachting were scheduled, but had to be cancelled due to poor weather on the planned day of competition.

Olympic games



1896, Athens

Orienteering

- At the end of the 19th century, all the requisites (including **unclassified topographic maps**, at least in some Scandinavian countries and in Britain) for orienteering as a sport were present.
- It was also the time where **the first tourist maps were published**, although most of the tourists used only tracks and paths in the forested areas (originally these tracks and paths were created for forestry or hunting purposes).
- In the mid-1890s, there was an interest in organized sports as the example of the successful establishment of modern Olympic Games. There was also an interest in long races over unknown ground especially in Scandinavia. These events were sometimes called orienteering races.

Orienteering

Norwegian topographic map
1:50000/30 m contour interval (1890)

Orienteering

Swedish topographic / economic map 1:100000 (1883-95)

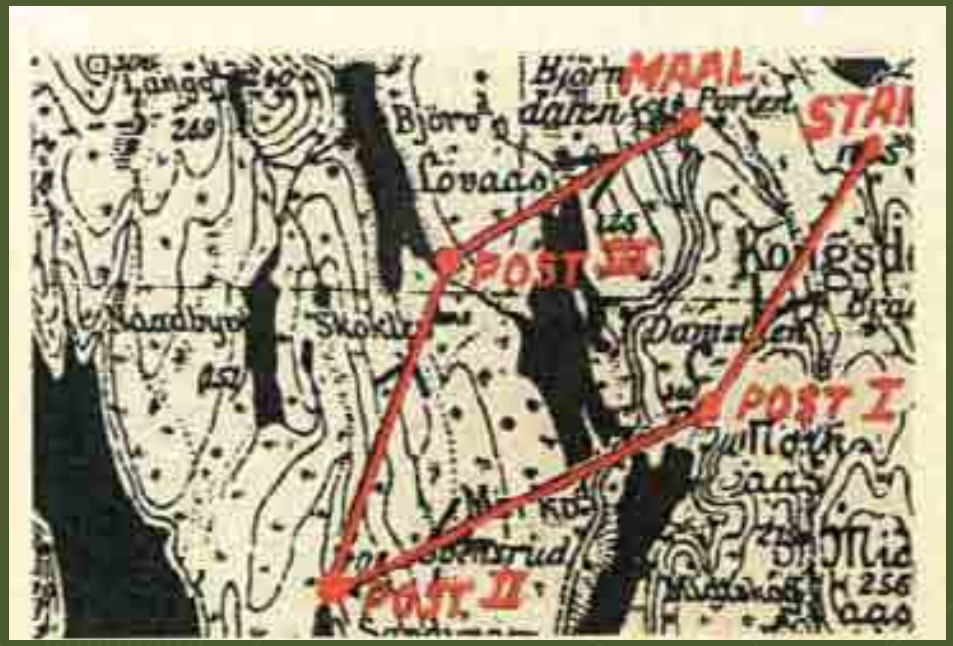
The first civil orienteering event

- In 1897, the Idrausforeningen (Sports Club) Tjalve wanted to try something new, an orienteering event.
- Explanation of the new form of event was not given except that maps and compass were allowed.
- Unfortunately, no record of the event is kept to prove that maps were really used in this first event, but the position of the three control points is known.
- Nevertheless it was probably impossible to finish the course in the time the best runners did without really using a map. There were four potential maps available for the runners to choose from.

Potential maps of the first civil orienteering event

- A topographic map at the scale 1:100 000 from 1872.
- A topographic map from 1885-87 based on measurement from 1880 with a 10 meter contour interval and 1:25 000 scale.
- A skiing map at 1:30 000 with a 20 meter contour interval (the most likely used map).
- A skiing map of 1:60 000 with a 100 feet contour interval from 1895.

Early orienteering maps in Scandinavia



1920

1927

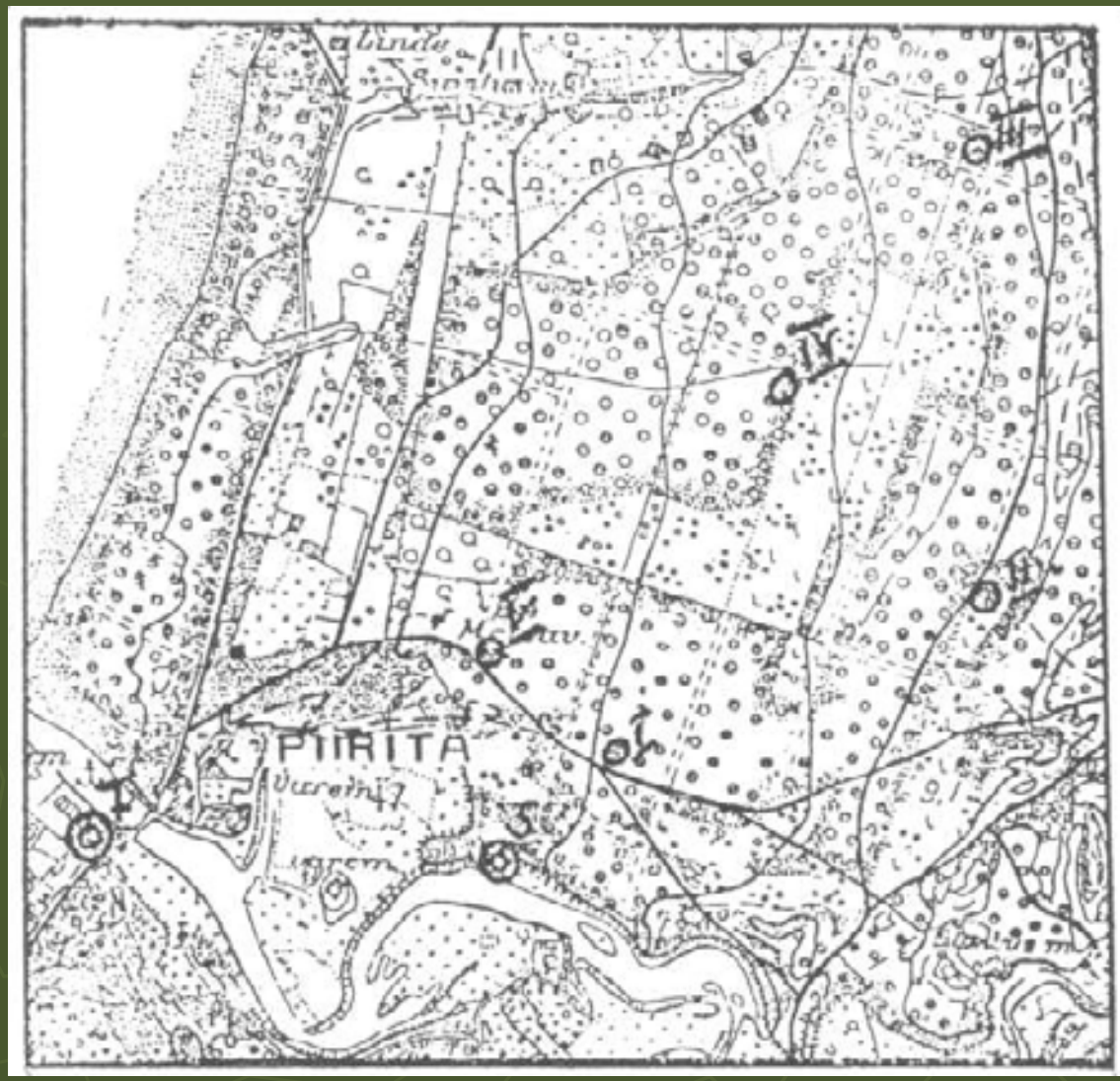
- The maps were extracts of the existing topographic maps.

The development in different Nordic countries

- 1899, Norway: the first ski-orienteering event
- 1906, Denmark: the first orienteering event
- 1922, Sweden, the first night-orienteering event
- 1925, Sweden, the first event for ladies
- **1931, Sweden: the first national championships in orienteering**
- **1932, Norway: the first international event**
- **1936, the establishment of Swedish Orienteering Federation**
- 1945, the establishment of Finnish and Norwegian Orienteering Federation, **the first orienteering magazine (Suunnistajat)**
- 1946, the establishment of Nordic Orienteering Association

The first orienteering events in some other countries

- Hungary, 1925.
- Estonia, 1926.
- Switzerland, 1930.
- Czechoslovakia, 1933.
- USA, 1941.
- Bulgaria, 1954.
- Australia, 1955.
- Brazil, 1955.
- Austria, 1962.
- Ukraine, 1963.
- France, 1965.
- Canada, 1966.



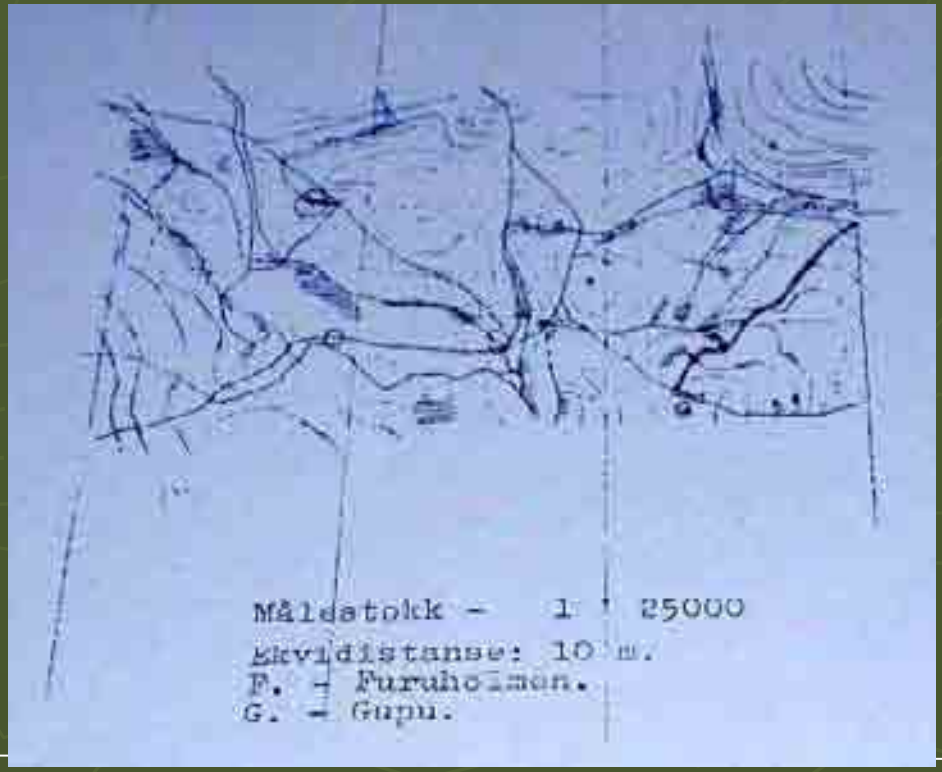
Map of the first Estonian orienteering event

Milestones of orienteering mapping

- The quick growth of the sport in Scandinavia is probably very much the result of a back to nature movement sweeping across Europe in the 1920s (“Wandervogel” movement).
- At the end of the 1920’es, there were about 5000 people who were considered active orienteers in **Sweden**. The sport grew so rapidly that it was considered a threat to some other established sports.
- Between the two world wars, there was only minor development in the maps used for orienteering.
- All Scandinavian countries created the first newly drawn maps, although these maps were based on existing topographic maps, but **no new information was added** to the maps.

Milestones of orienteering mapping

- The first orienteering map that was **especially drawn and field-worked for orienteering** was made in 1941 in Norway. This was an illegal night orienteering event during the German occupation, when the organizers had no other chance to have suitable map for an orienteering event.

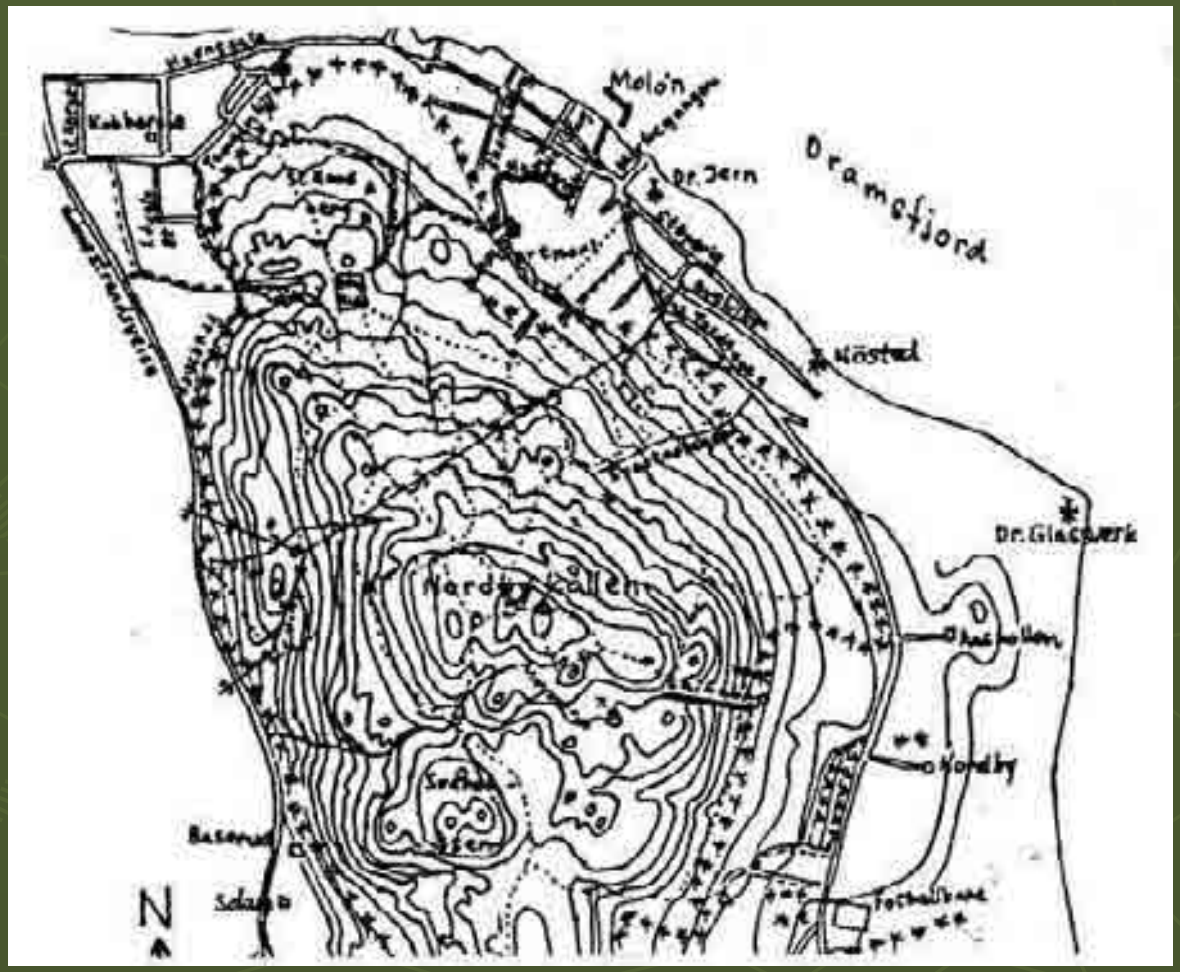


Milestones of orienteering mapping

- During WW II, the sales of maps were stopped in most Scandinavian countries, but after negotiations, reprints of maps for sanctioned orienteering events were allowed.
- Still the organizers were not allowed to make any corrections or additions to the maps.
- Although the Swedish orienteering was the strongest and the most developed before WW II, technical improvements in the sport was no longer a realm of the Swedes either.
- The mapping revolution after WW II started in **Norway** shortly after the war and it was not until 1965 that Swedish orienteering realized what was going on.

Milestones of orienteering mapping

- 1948: Norbykollen, Norway: The first orienteering map made by using **airphotos**.



Milestones of orienteering mapping

- 30 April 1950, around Oslo, Norway. The first colour (offset printed) orienteering map.

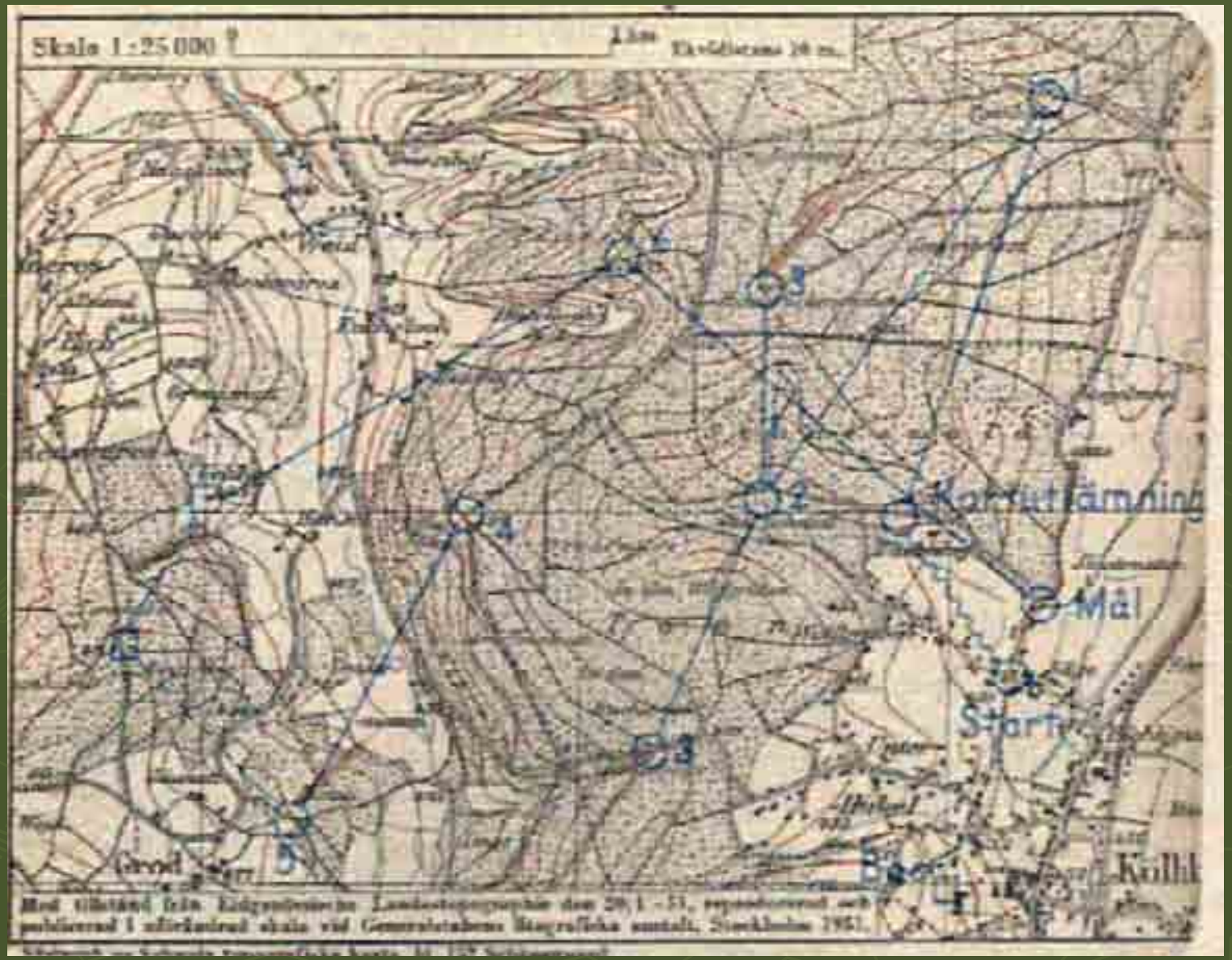
Milestones of orienteering mapping

- Although the very first colour offset orienteering map was created in 1950 for an international event, but for at least 10-15 years colour maps were rarely used (due to the high price of printing).
- According to the running speed and the course distance, the scale of maps was 1:20 000-1:40 000 (1:50 000-1:100 000 in the early years).
- In some countries, the topographic maps were classified (Eastern Europe), in other areas the largest available scale of topographic maps was only 1:50 000 (Germany, Spain).
- Using tourist maps was a logical alternative, but in Eastern Europe the accuracy of publicly available tourist maps was not suitable for these events. Therefore, these countries tried to find more accurate tourist maps published before the communist era.

Samples

Norway
1947

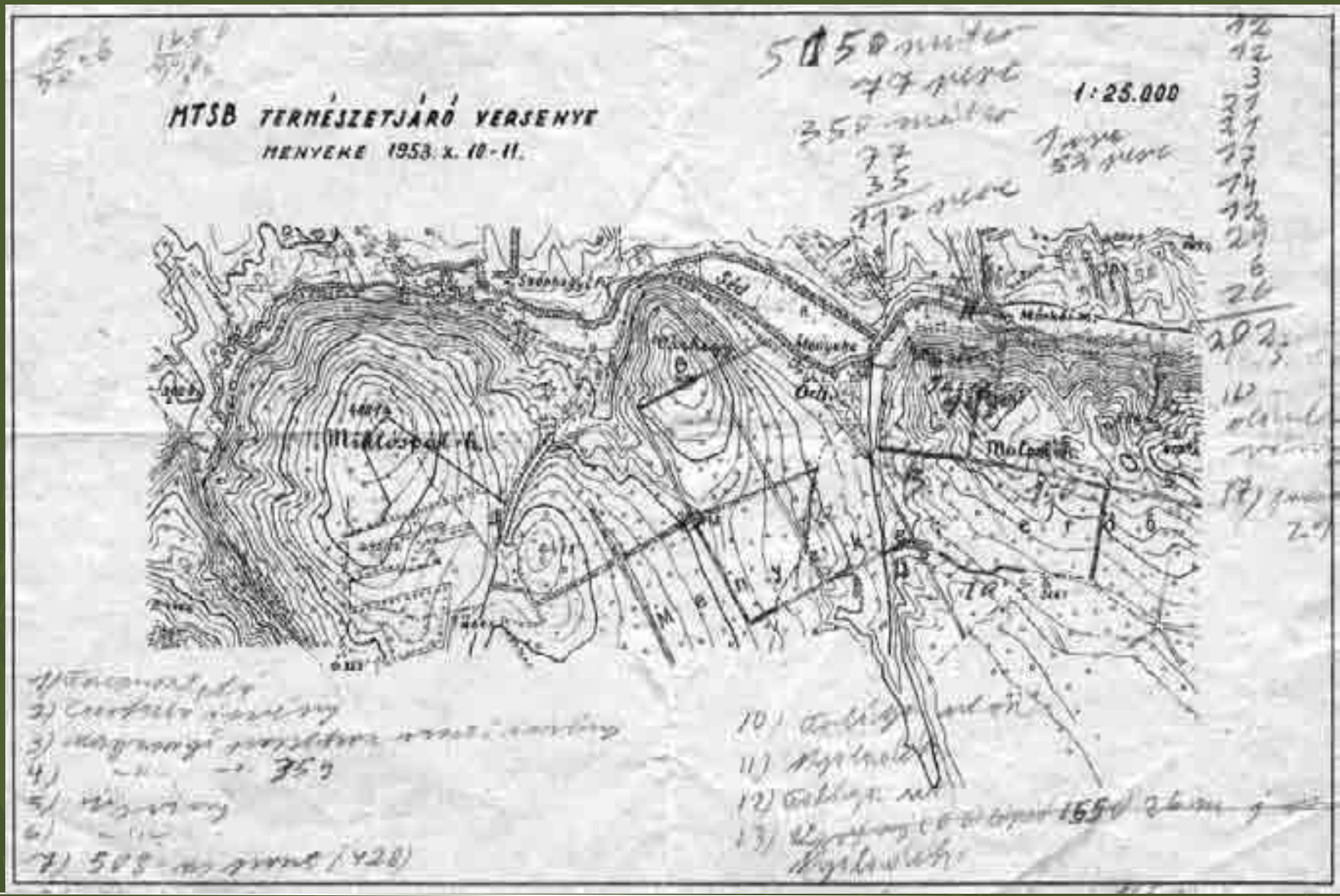
Samples



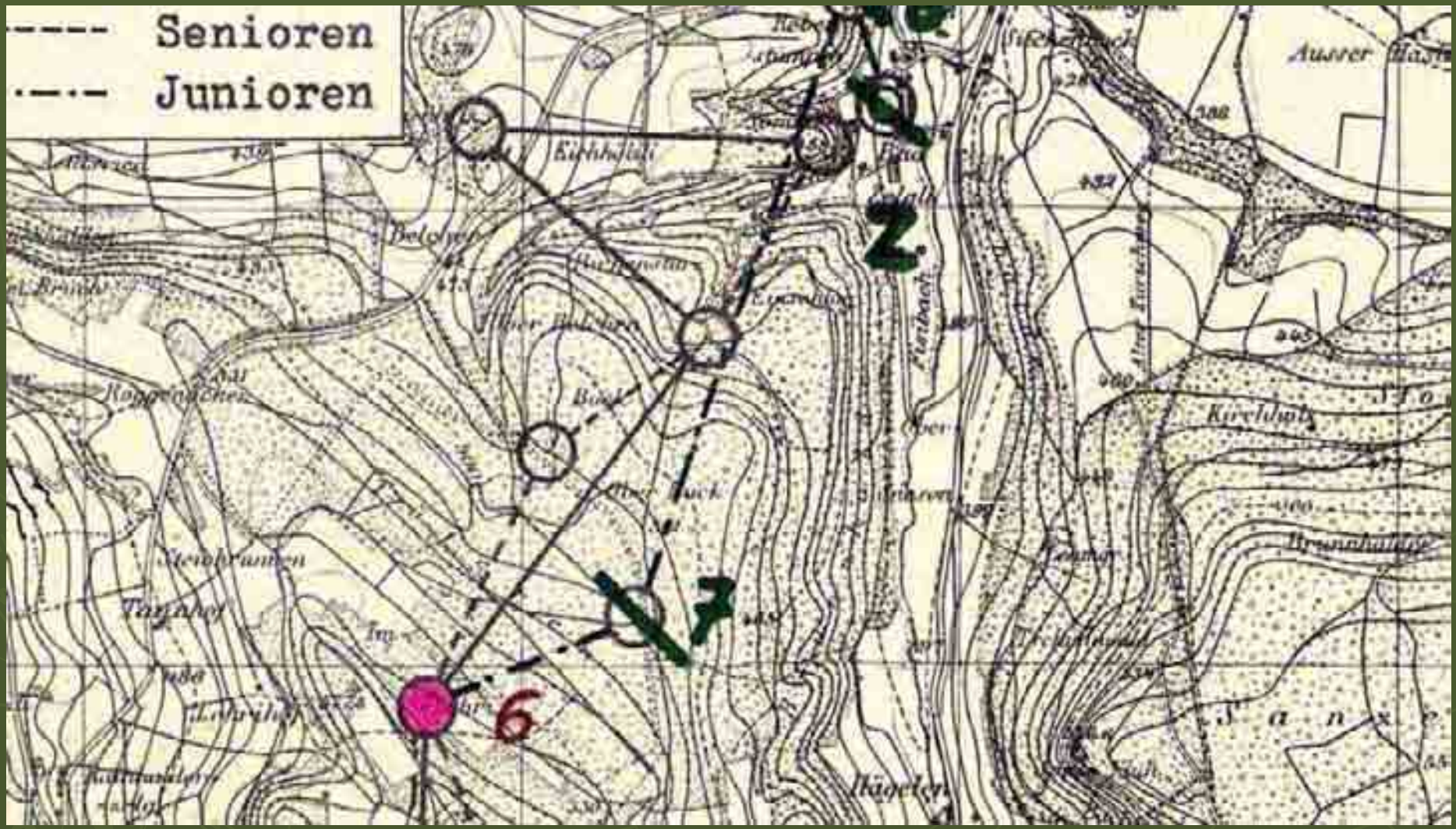
Switzerland
1950

Samples

Hungary
1953



Samples

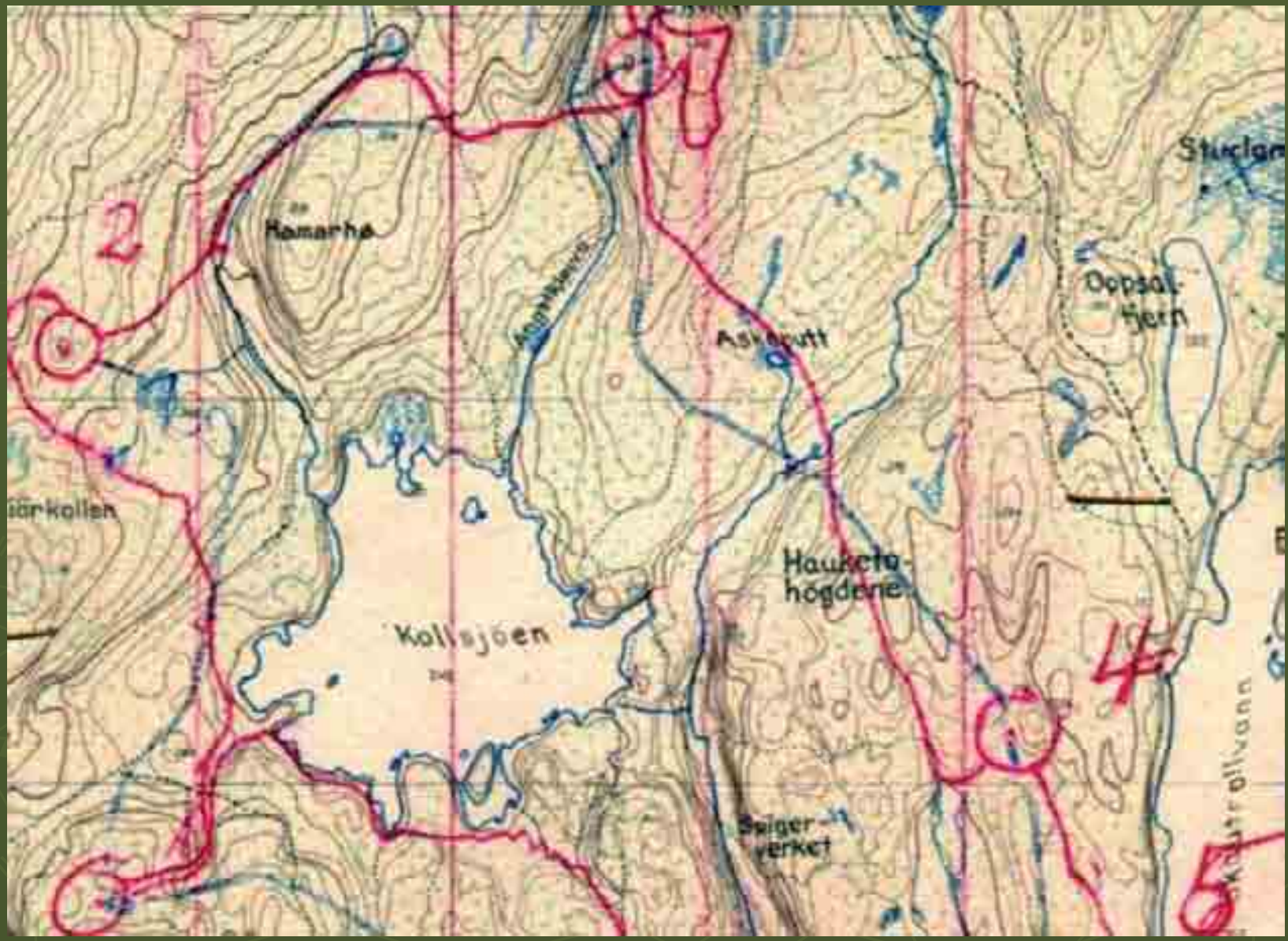


Switzerland
1954

Samples

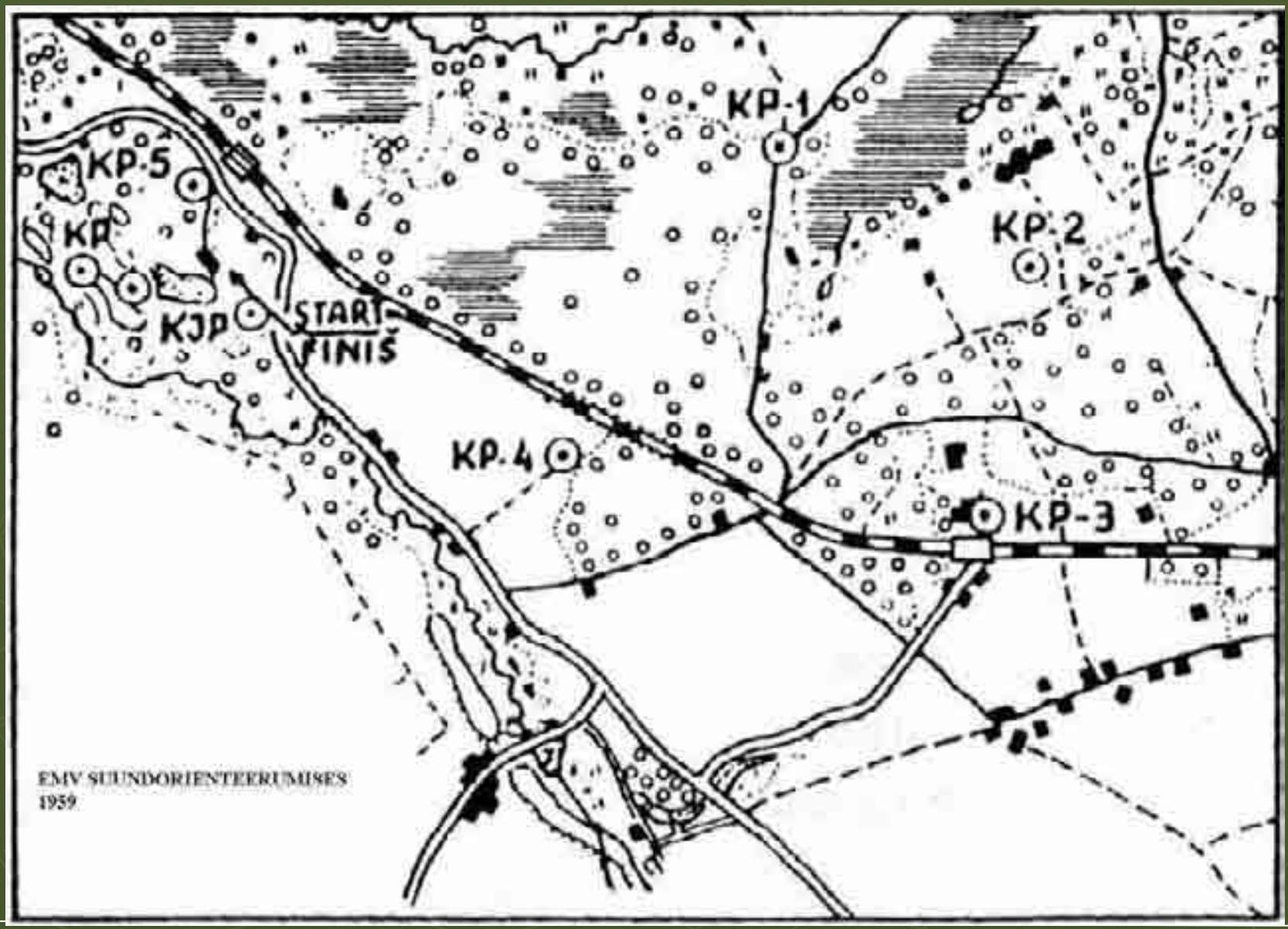
Sweden
1955

Samples



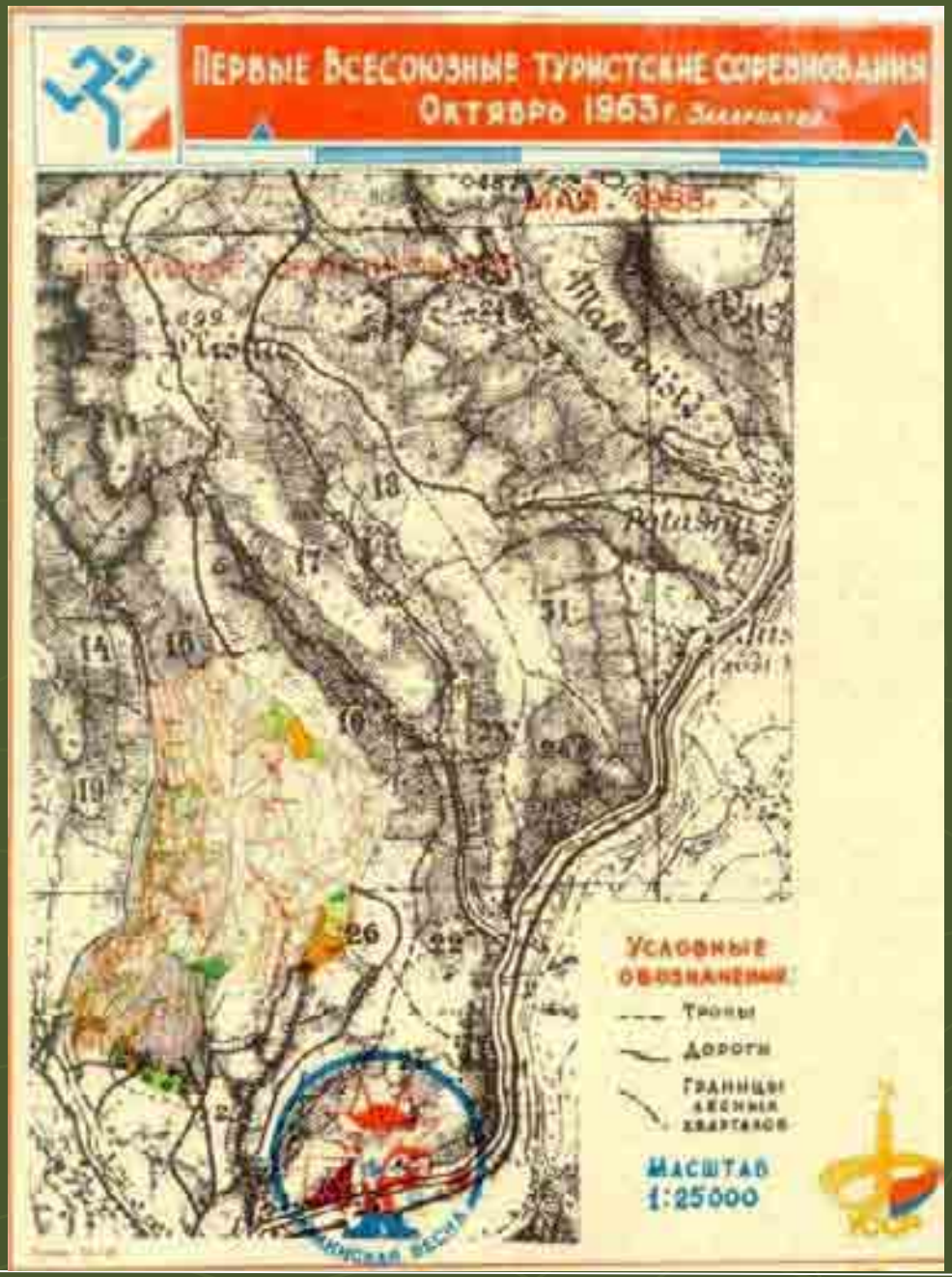
Norway
1956

Samples



Estonia
1959

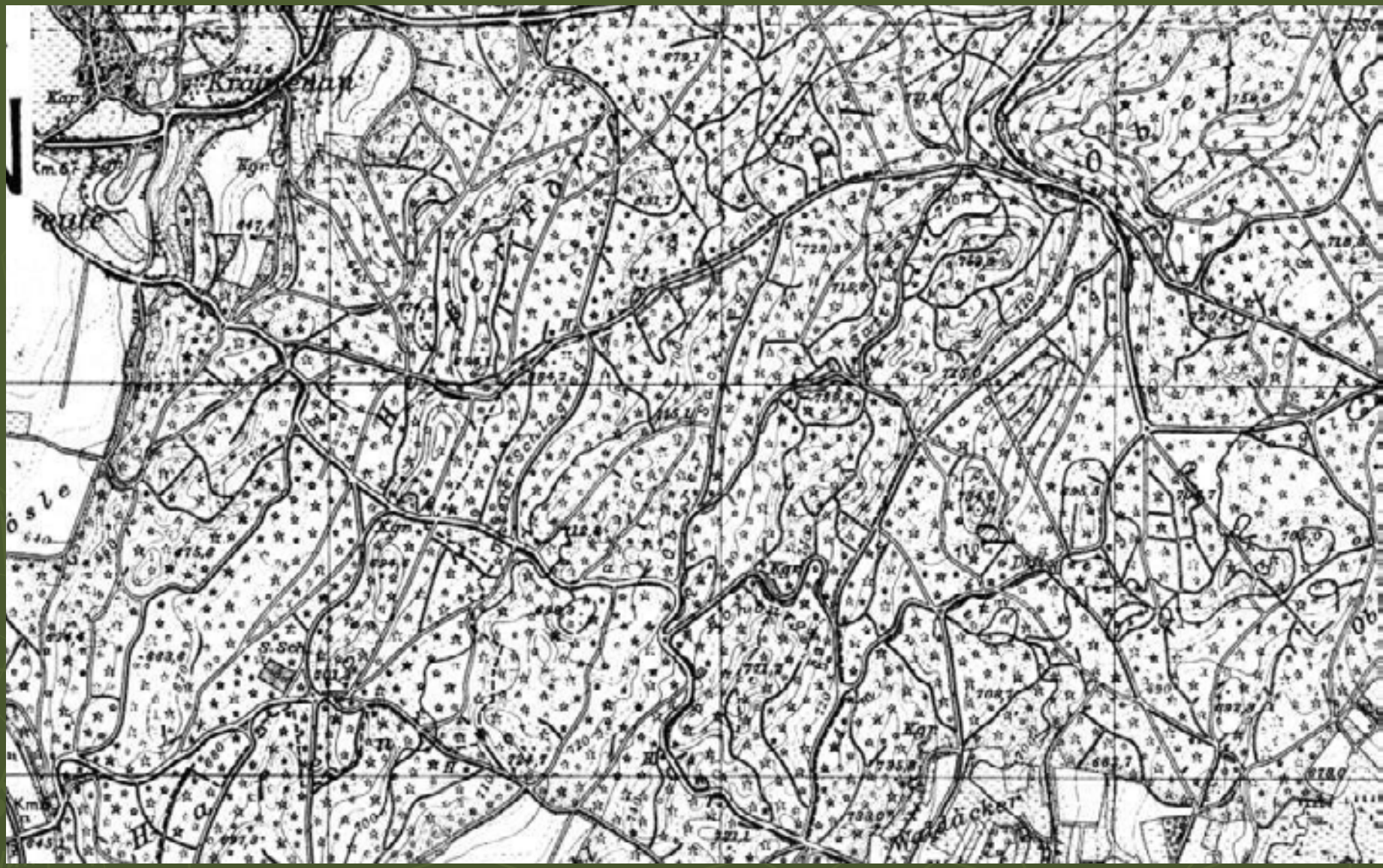
Samples



Ukraine (Soviet Union), 1963

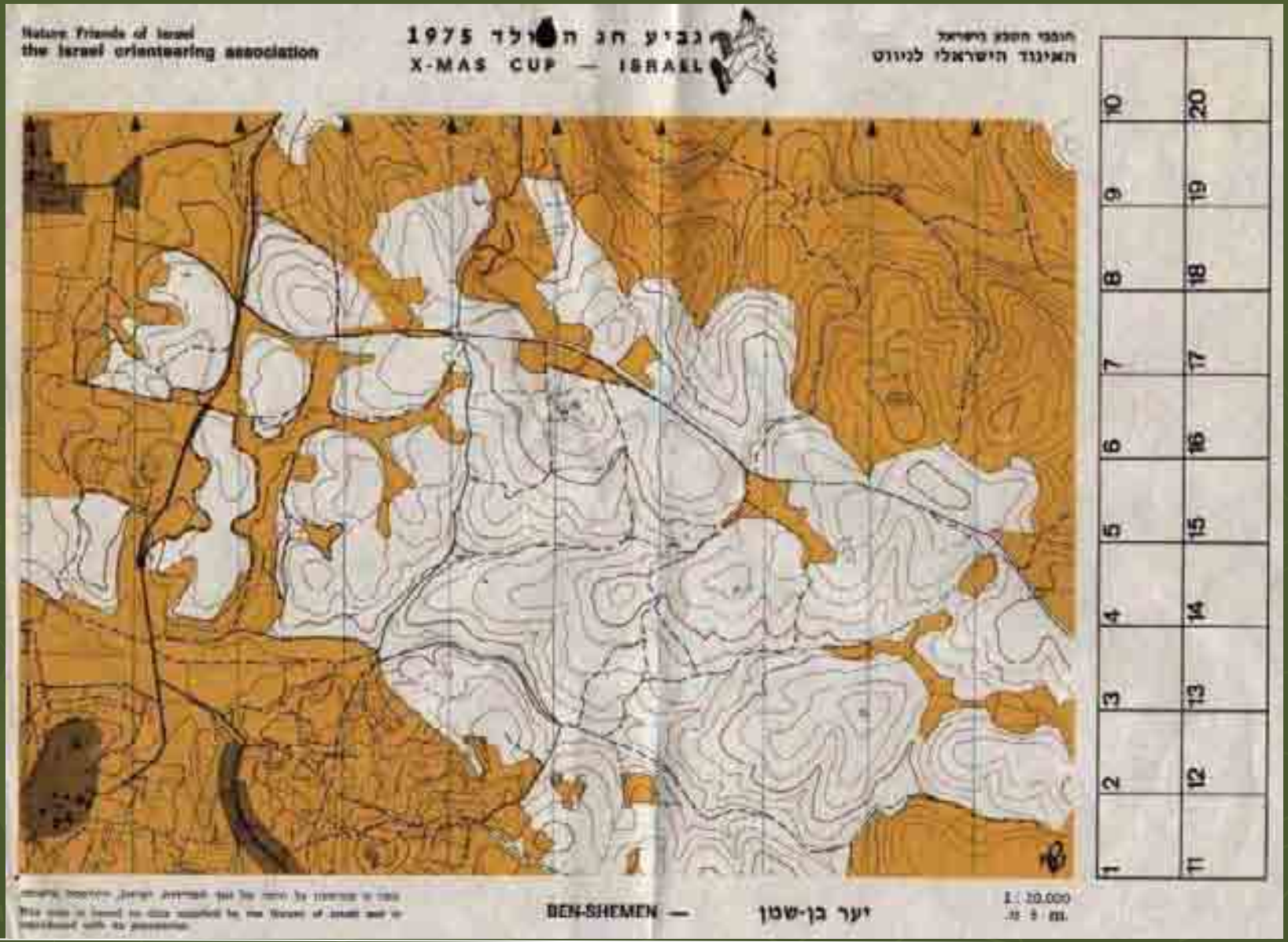
Samples

Germany, 1964



Samples

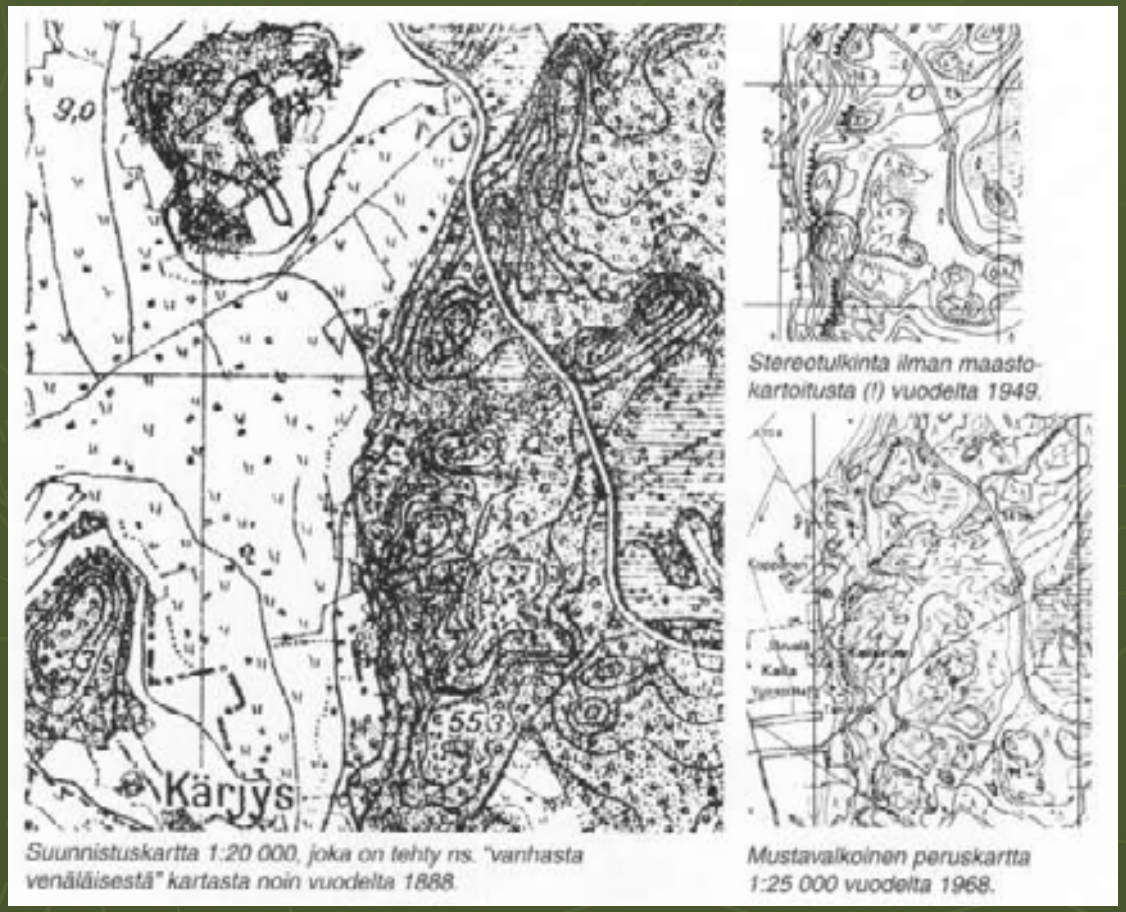
Israel, 1975

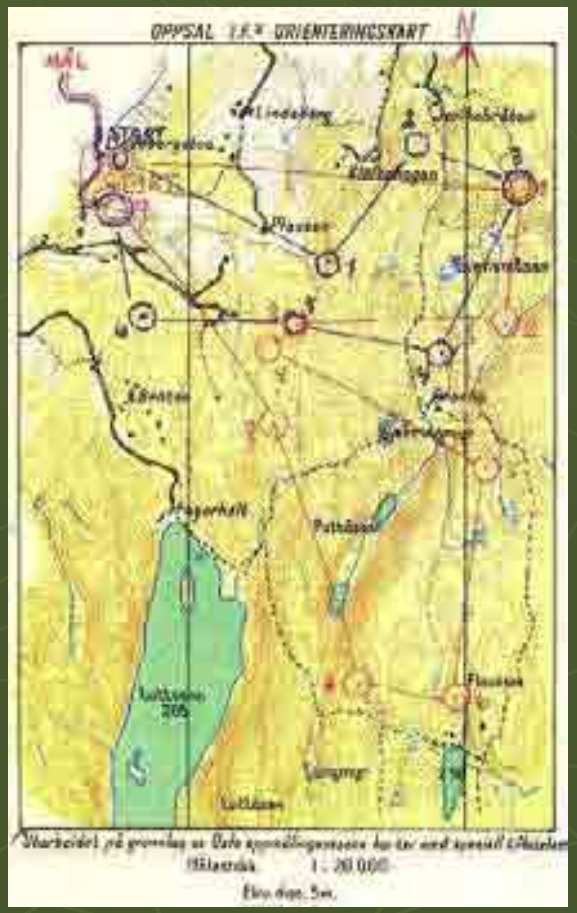


How did the orienteering start ? (1)

„Scandinavian” style (Norway, Sweden, Finland, Switzerland, Denmark):

Independent development using topographic maps of the countries.

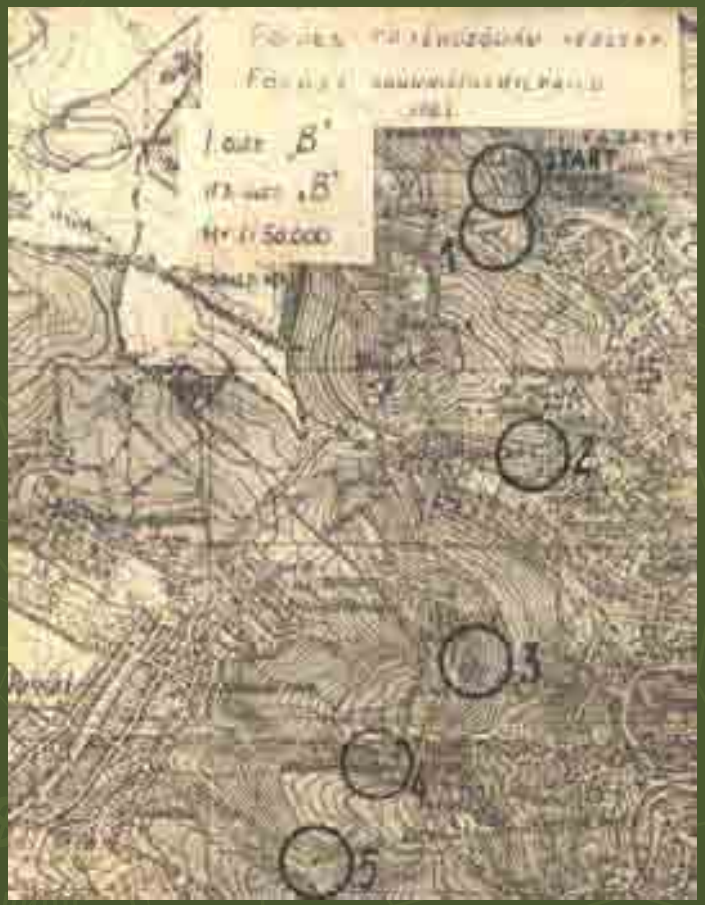


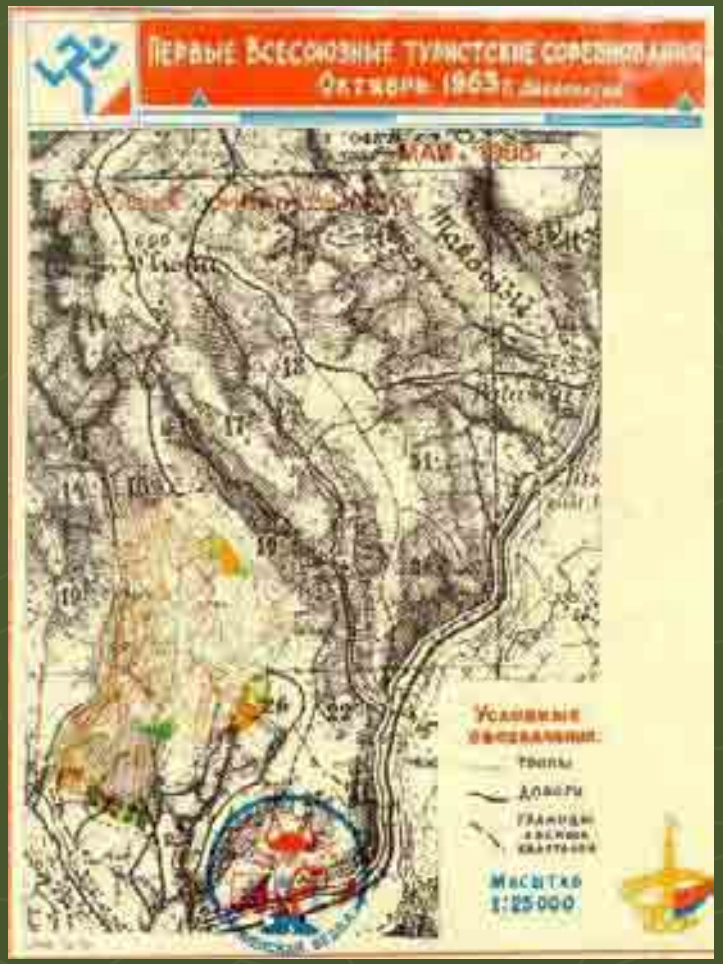


How did the orienteering start ? (2)

„Eastern European style” (HUN, CZE, BUL, GDR):

Based on tourism, used old tourist maps, because topographic maps were classified.





How did the orienteering start ? (3)

Modern style (AUS, AUT, CAN, FRA, USA etc.)

Based on international (mostly Scandinavian) experiences.
After the foundation of the International Orienteering Federation.

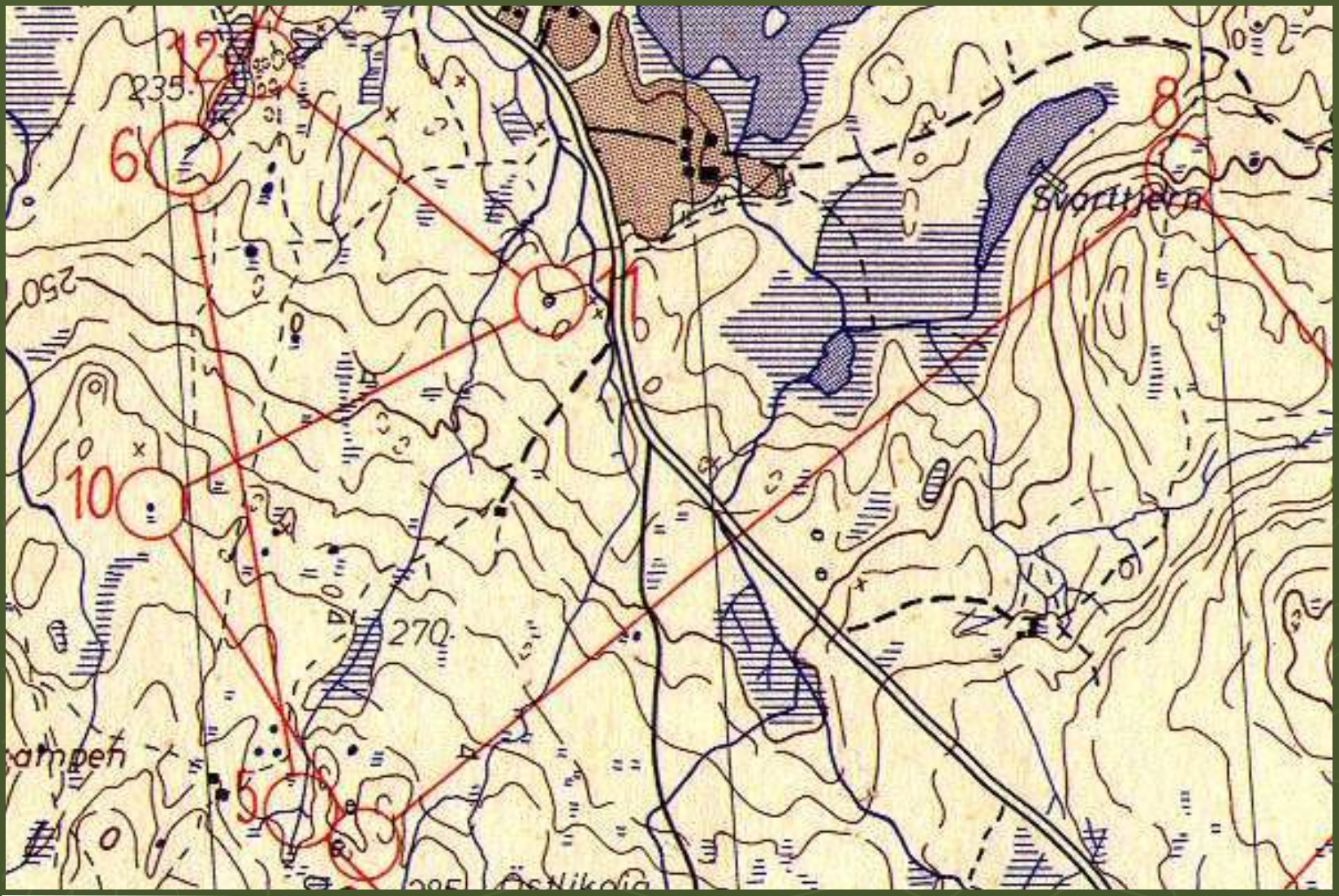
The foundation of the IOF

- The real development of orienteering maps started with the “official” internationalization process (standardization – fair events).
- The International Orienteering Federation was founded in 1961 by four Eastern European and six West European countries.

Finland	Bulgaria
Denmark	Czechoslovakia
Germany (FRG)	Germany (DDR)
Norway	Hungary
Sweden	
Switzerland	

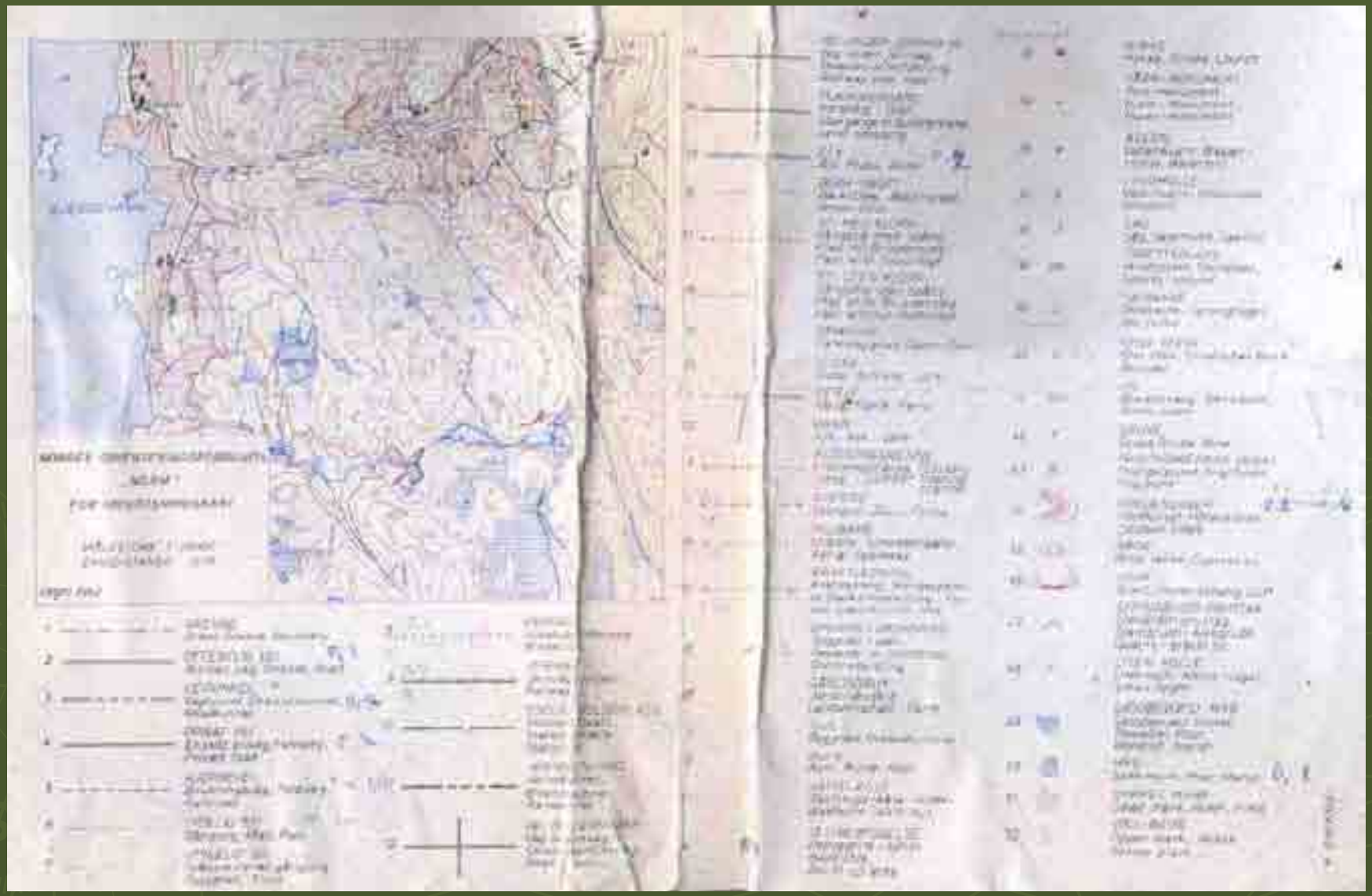
- In 1962, the first European Championships was organized in Norway. The maps of the first international championships used the legend of the national topographic maps of the organizing country. This did not make the events absolutely fair, because the interpretation of map symbols was easier for the local participants.

European Championships, 1962

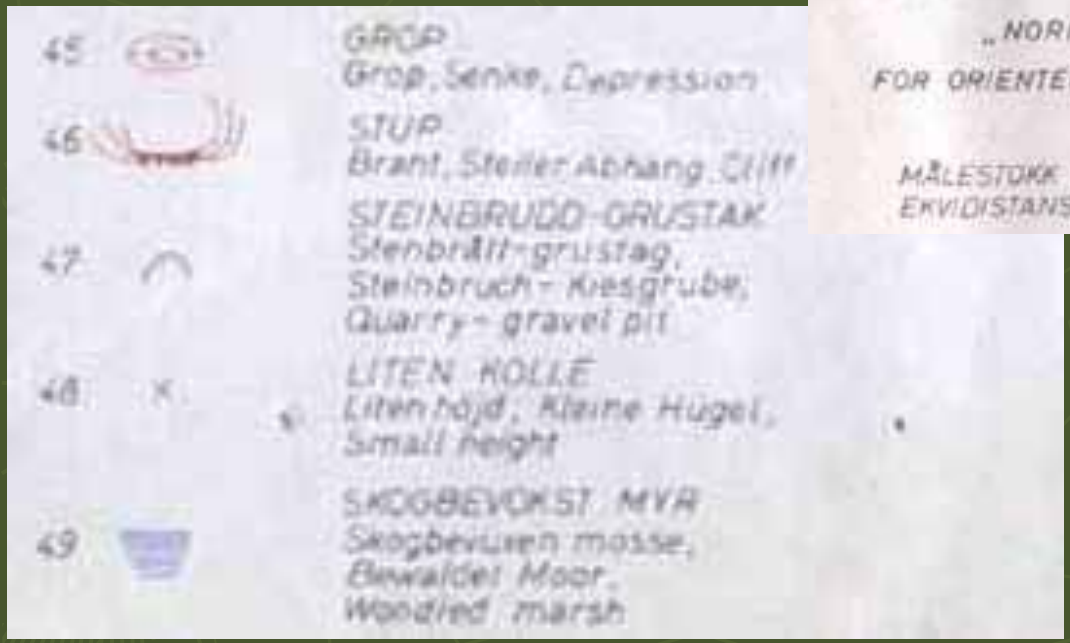


Norway

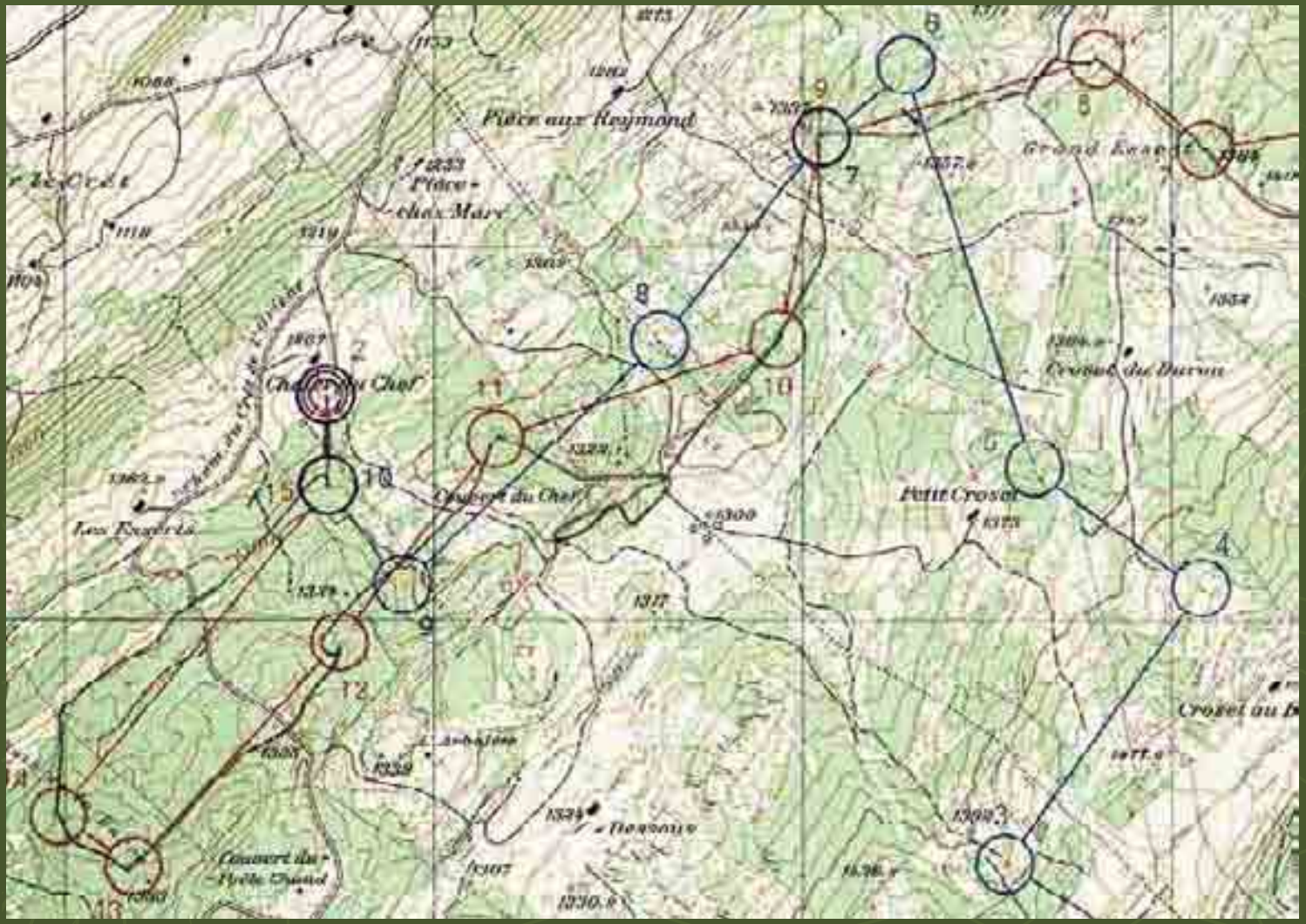
Pre-ISOM, European Championship, Norway, 1962



Pre-ISOM, European Championship, Norway, 1962



European Championships, 1964



Switzerland

The 1st World Championships, 1966

Finland

Standardization of orienteering maps

1961 – MC of the Norwegian Federation
1964 – MC of the Swiss Federation
1965 – IOF MC

Members:

- Jan Martin Larsen – Norway
- Christer Palm – Sweden
- Ernst Spiess – Switzerland

1967 – First meeting of IOF MC (Zürich)

Participants:

- Jan Martin Larsen – Norway
- Torkil Laursen – Denmark
- Osmo Niemelä – Finland
- Christer Palm – Sweden
- Ernst Spiess – Switzerland

Map Committee of the IOF

The International Orienteering Federation formed a Map Committee to establish a map standard, but the process was relatively slow because all the dominant orienteering countries suggested their own map standards (which was practically the symbols of their national topographic maps). The Map Committee finally agreed on the main principles at their first meeting in 1967:

- The orienteering maps must show the actual situation.
- They must show all visible features that are easily identifiable and useful for the competitors.
- It is very important to show all details that affect the route choice.
- The legibility is most important: leave out all unnecessary features.
- The maps of the international events have to use the same legend in all countries.

Professional cartography and orienteering

The first scientific papers on orienteering maps in cartographic journals:

- Palm, Christer: Kartor för Orienteering

Globen (Sweden), 1970. 1-2. 12-20.

- Kirby, R.: The Geographical Sport of Orienteering

Geography, 1970/3. 285-288.

- Palm, Christer: Maps for Orienteering

International Yearbook of Cartography, 1972. 130-136.

- Spiess, Ernst: International genormte topographische Karten für den Orientierungslauf

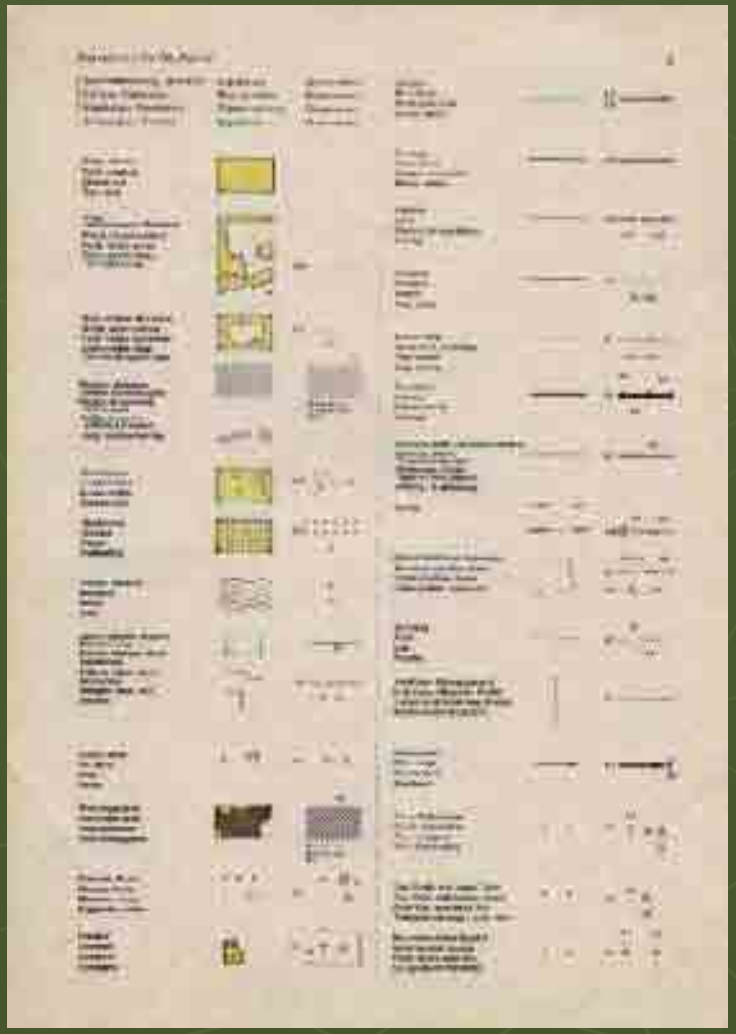
International Yearbook of Cartography, 1972. 124-129.

- G Petrie: Orienteering maps

Cartographic Journal, 1977. June 14-22.

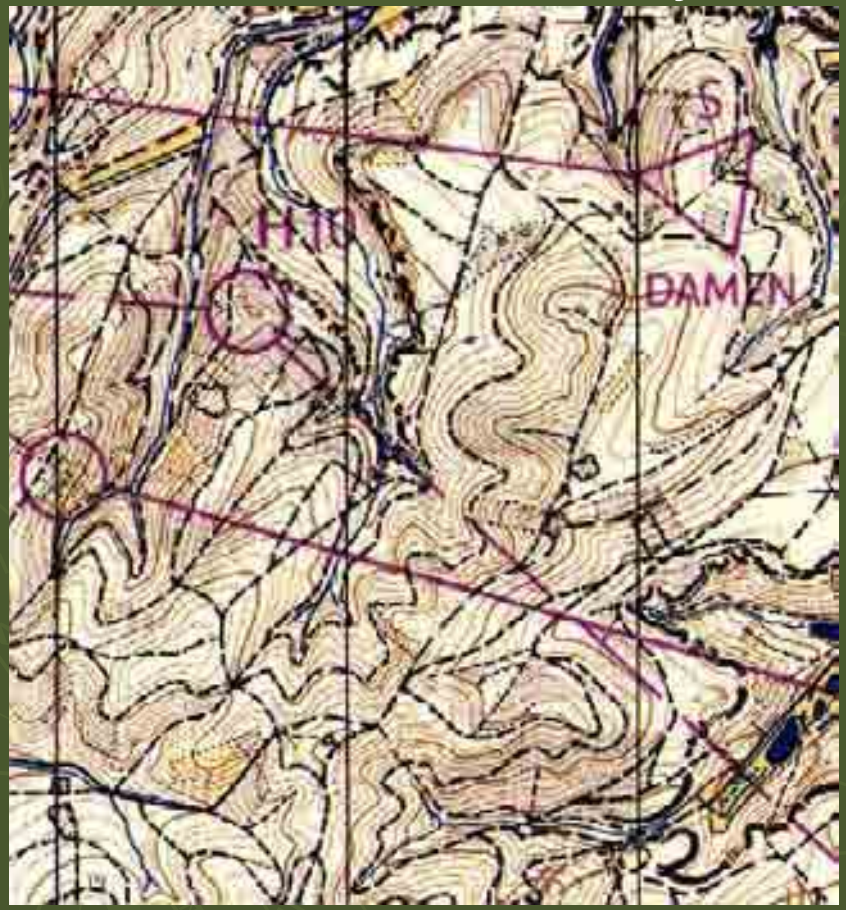
ISOM 1969

Languages: German, English, French, Swedish



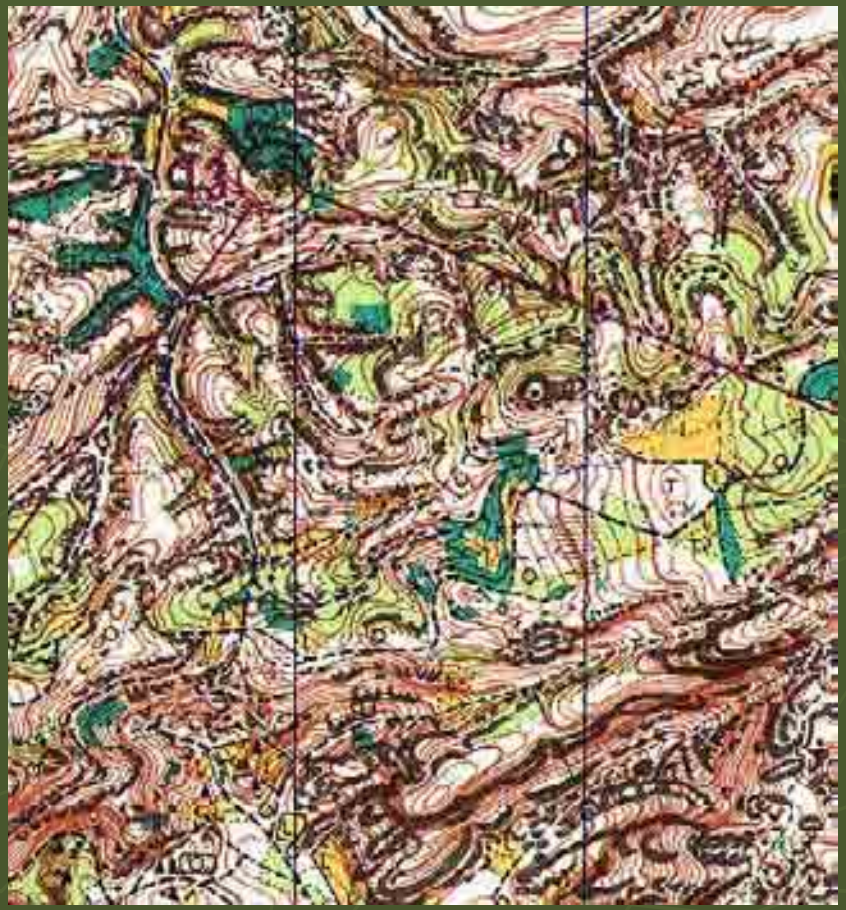
WOC maps

1970 – East Germany



1:25000 scale last time

1972 – Czechoslovakia



The first use of 3 greens for runability

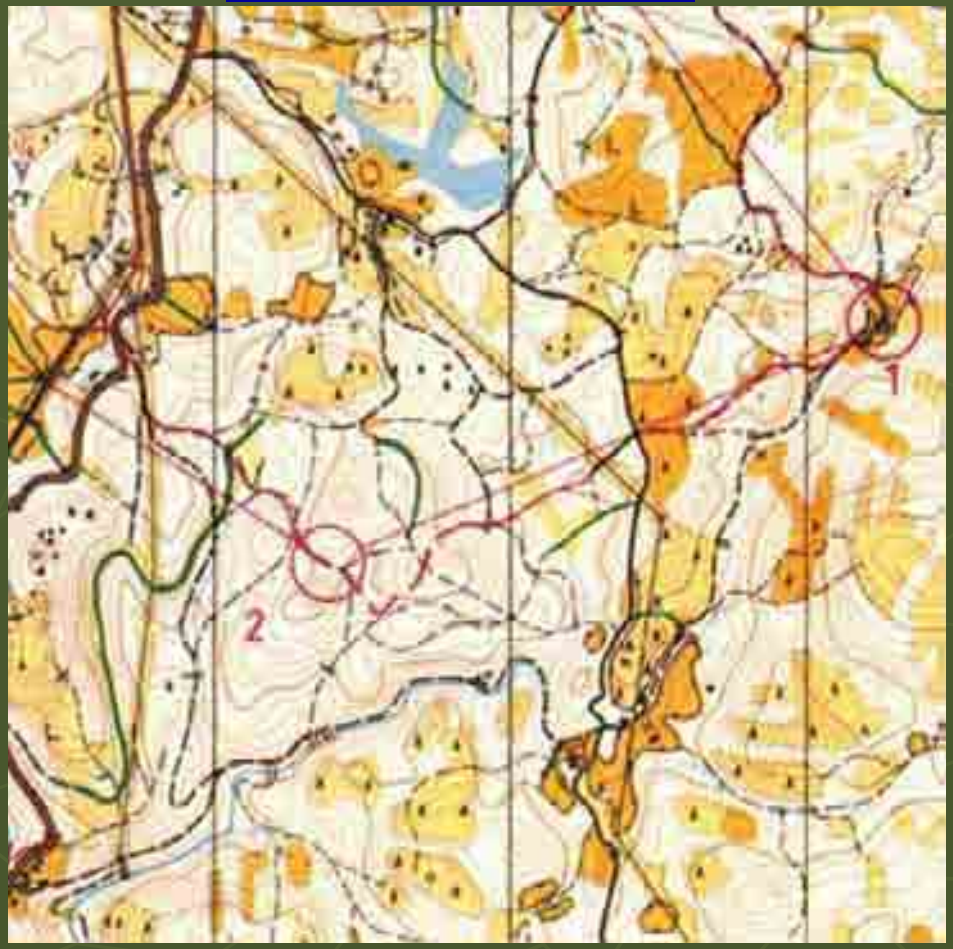
ISOM 1975

- Scale: 1:20 000 or 1:15 000,
- green in three shades for the representation of restricted runability due to vegetation,
- yellow screen or diagonal stripes for semi-open terrain (clearings and felled areas),
- grey for bare rock.

Ski-o

1975 – Finland

1977 – Bulgaria



First ski-o WOCs, without special map specification

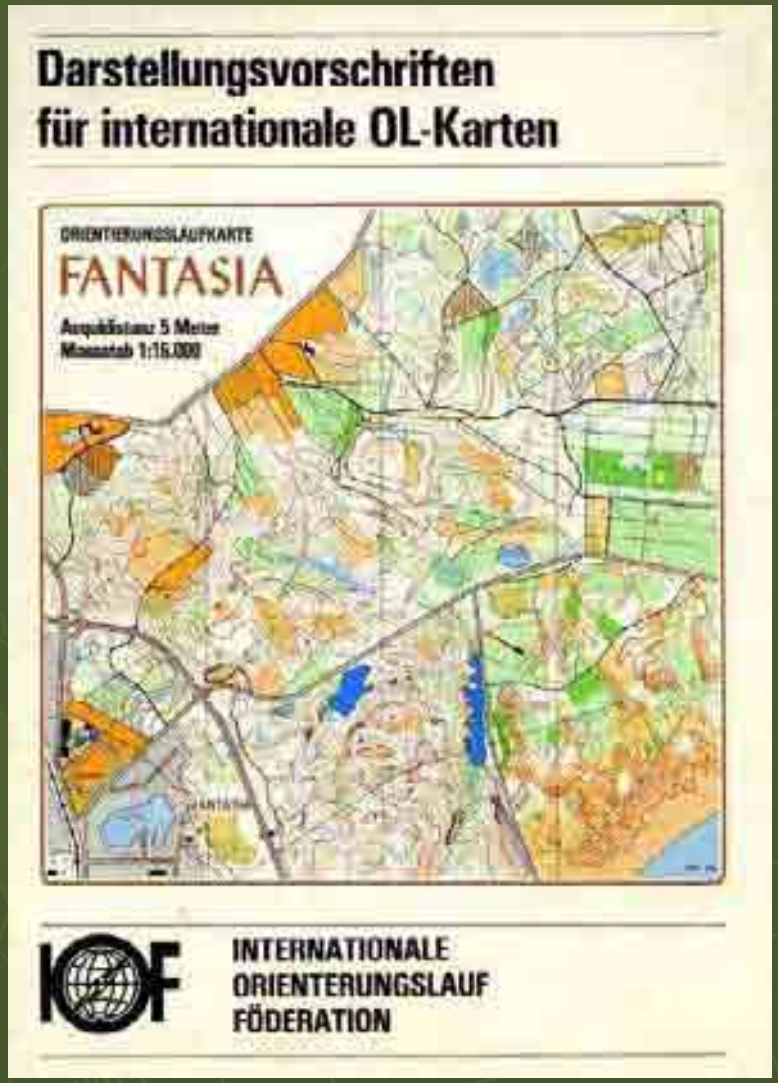
1976 – Scotland

1:15000 scale in relay

1978 – Norway

First time: 1:15000 scale in classic

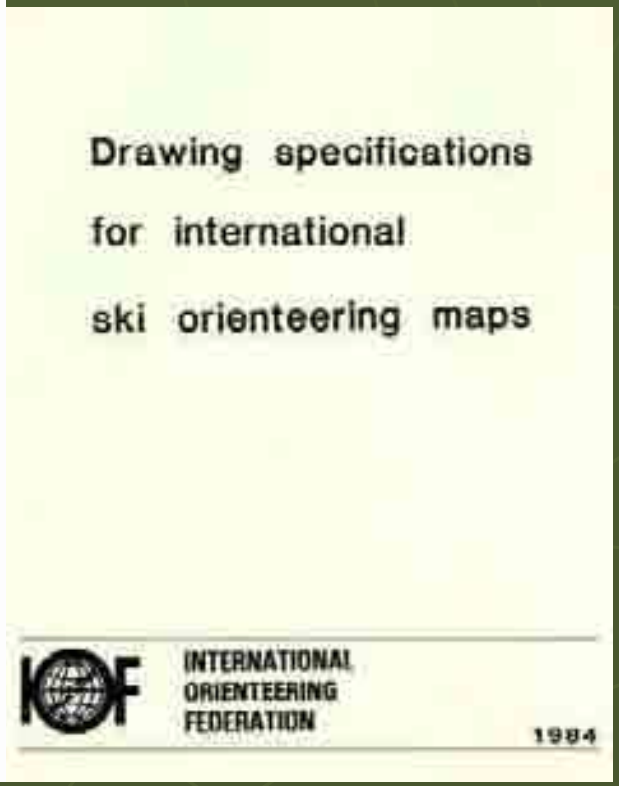
ISOM 1982



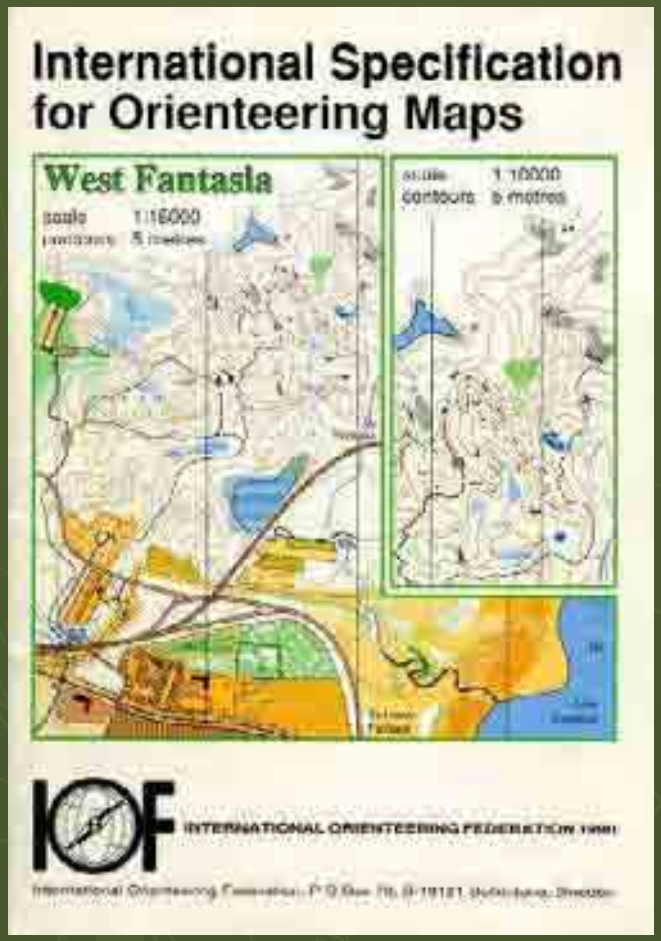
- Scale: 1:15 000 or 1:10 000,
- introduction of yellow screens to extend the possibilities for combining colours and thus better representing vegetation and runability,
- green stripes to represent restricted runability with good visibility,
- changed print colours brown, yellow and green.

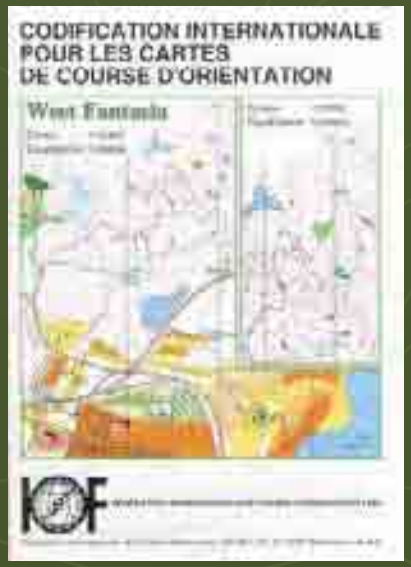
Ski-o map specification (1984)

- Scales: 1:20000, 1:25000, 1:30000.
- Equidistance: 5 or 10 m.
- 3 types of green tracks: fast, good, slow.
- Symbols of foot-o maps to be used



ISOM 1990





- From a "guideline" to a "rule set" by continuous improvement of colours and symbols on the basis of extensive tests and studies,
- increased scale from 1:40 000 >1:25 000 > 1: 20 000 >1:15 000 > 1:10 000,
- extension of the time between revisions from 6 years via 7 and 8 to 10 years.

ISOM 2000

- No big changes,
- existing standards are adjusted for computer mapping,
- Special printing chapter; consideration of new printing methods,
- inclusion of other forms of orienteering.

International Specification of Orienteering Maps

Year of publishing	Number of symbols	Suggested scale
1969	52	1:25000 1:20000
1975	100	1:20000 1:15000
1982	98	1:10000 1:15000
1990	105	1:10000 1:15000
2000	104	1:10000 1:15000

Orienteering is a sport involving non-motorised navigation with a map

Official disciplines:

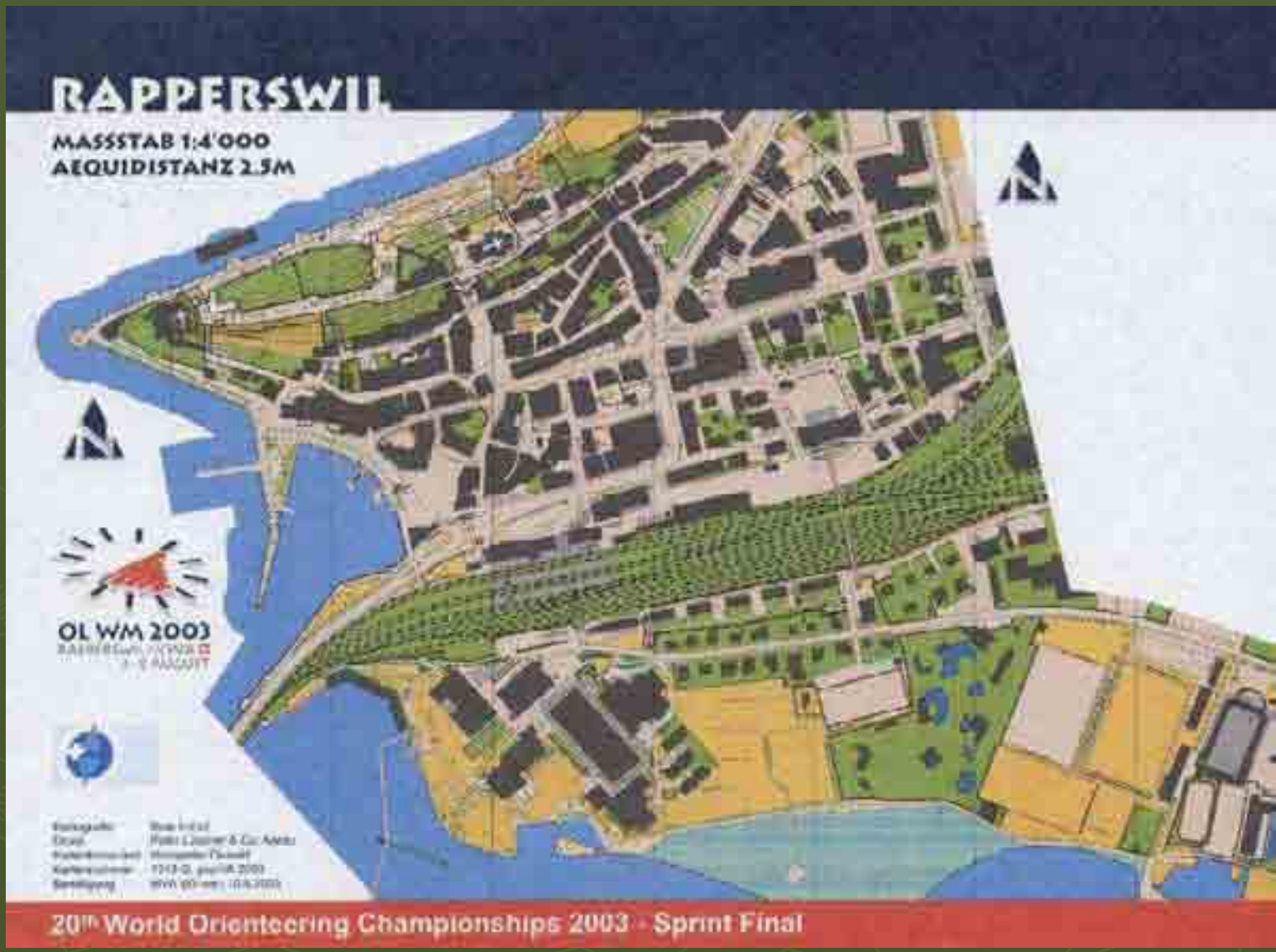
- Foot Orienteering
- Ski Orienteering
- Trail Orienteering
- MTB Orienteering

Foot Orienteering

WOC year	Venue
2015	Strömstad (SWE)
2014	Trentino (ITA)
2013	Vuokatti (FIN)
2012	Lausanne (SUI)
2011	Savoye (FRA)
2010	Trondheim (NOR)
2009	Miskolc (HUN)
2008	Olomouc (CZE)
2007	Kiev (UKR)
2006	Århus (DEN)
2005	Aichi (JAP)

WOC year	Venue
2004	Västerås (SWE)
2003	Rapperswil/Jona (SUI)
2001	Tampere (FIN)
1999	Inverness (GBR)
1997	Grimstad (NOR)
1995	Detmold (GER)

The first sprint WOC – Switzerland 2003



Specialities of foot-o maps

- Very detailed, especially the relief representation.
- Only visible (prominent) features are mapped.
- Relative accuracy is more important than the absolute accuracy (not necessarily georeferenced).
- Forest areas are represented according to their runability (crossability).
- General scale 1:15000 (1:10000 scale is a 150% enlargement).
- Different map specification for sprint orienteering maps: urban, park areas (larger scale: 1:4000-1:5000).

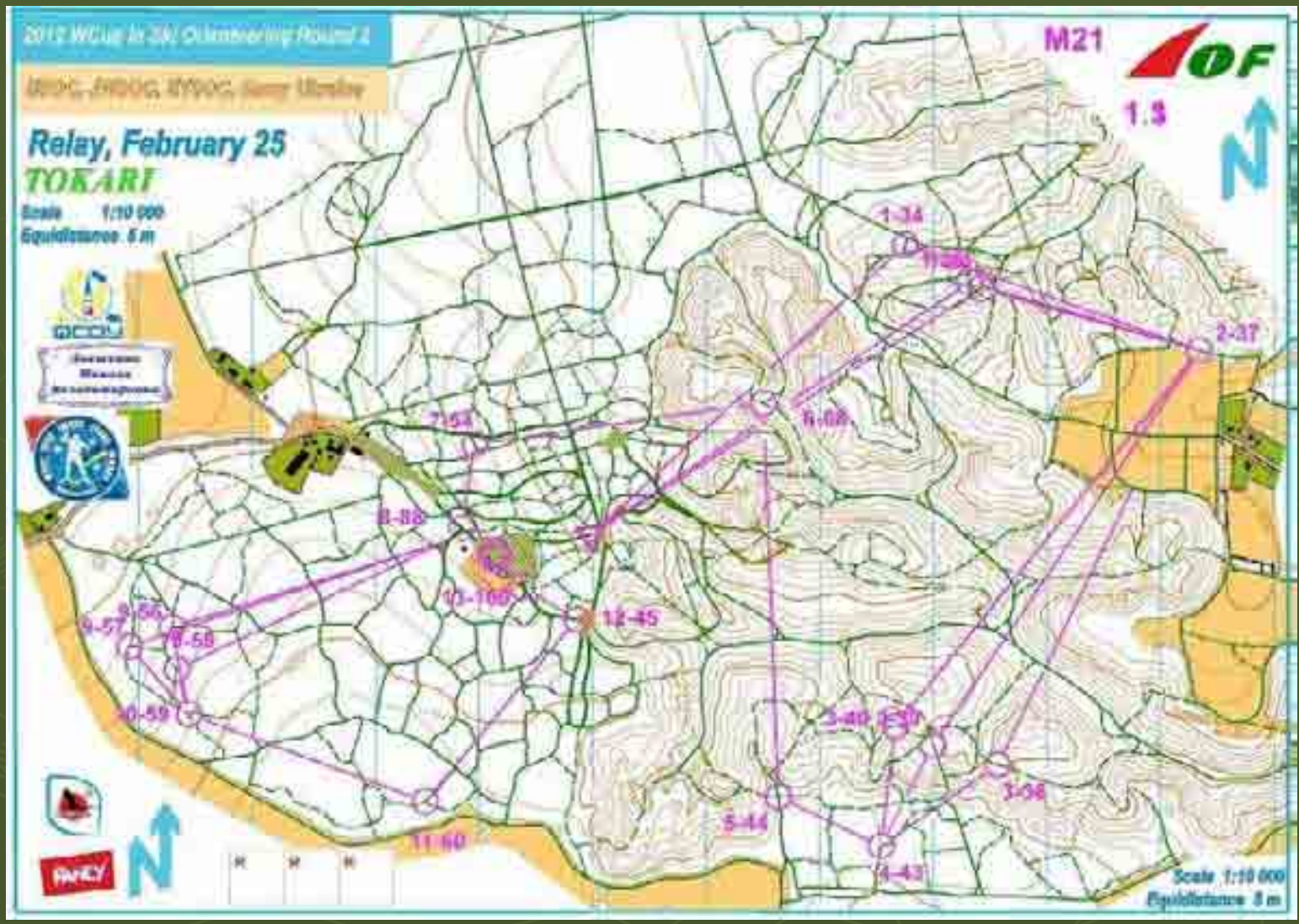
Ski Orienteering

WOC year	Venue
2013	Ridder City (KAZ)
2011	Tänndalen (SWE)
2009	Rusutsu (JAP)
2007	Moscow region (RUS)
2005	Levi/Kittilä (FIN)
2004	Åsarna/Östersund (SWE)
2002	Borovetz (BUL)
2000	Krasnoyarsk (RUS)
1998	Windischgarsten (AUT)
1996	Lillehammer (NOR)
1994	Val Di Non (ITA)
1992	Pontarlier (FRA)
1990	Skellefteå (SWE)
1988	Kuopio (FIN)

Specialities of ski-o maps

- Skiing is faster than running > smaller scale is more appropriate (1:20000-1:25000).
- All terrain details are covered by snow, not necessary to represent the runability.
- Snow conditions can change before the event (fast and flexible printing methods are necessary).
- Track and path network is the made for the event, crossing is allowed, but sometimes requires too much time.

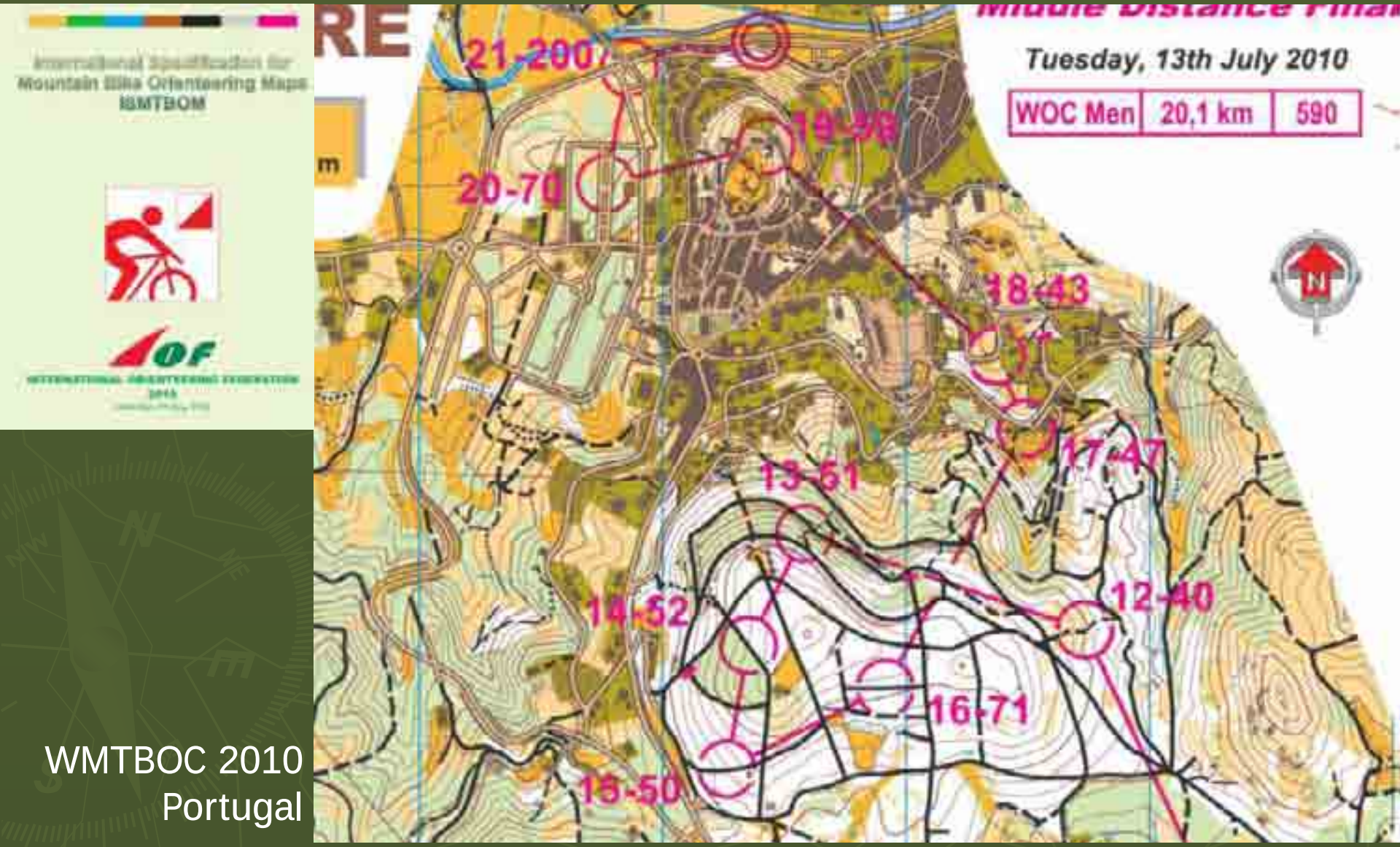
WOC 2012
Ukraine



MTB Orienteering

WOC year	Venue
2014	Bialystok (POL)
2013	Rakvere, Lääne-Viru county
2012	Veszprém (HUN)
2011	Vicenza (ITA)
2010	Montalegre (POR)
2009	Ben Shemen (ISR)
2008	Ostróda (POL)
2007	Nové Mešto na Moravě (CZE)
2006	Joensuu (FIN)
2005	Banská Bystrica (SVK)
2004	Ballarat, Victoria (AUS)
2002	Fontainebleau (FRA)

1st WMTBOC, France, 2002



WMTBOC 2010
Portugal

Specialities of MTBO maps

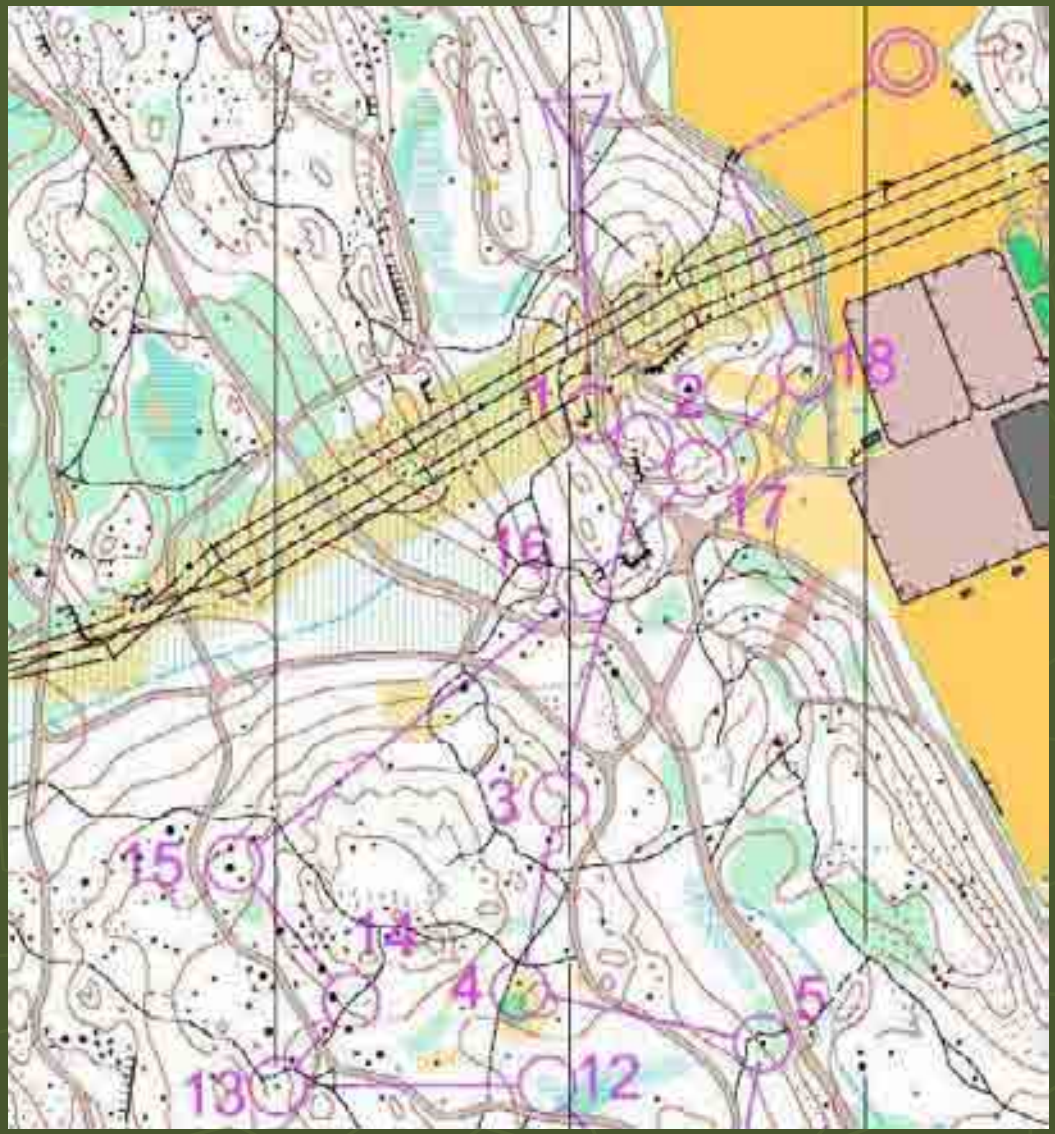
- Biking is faster than running > smaller scale is more appropriate (1:20000-1:25000).
- Bikers are regularly using the track and path network (some countries off-track riding is prohibited), not necessary to represent small features.
- Map gholder are fixed on bikes, but the size is limited (too large maps are not suggested).
- Track and path network is the most important, bikers reading the maps while they are riding: enlarging of track and path system is necessary, less relevant features can be underemphasized.

Trail orienteering

WOC year	Venue
2015	Strömstad (FIN)
2014	Trentino (ITA)
2013	Vuokatti (FIN)
2012	Dundee (GBR)
2011	Savoye (FRA)
2010	Trondheim (NOR)
2009	Miskolc (HUN)
2008	Olomouc (CZE)
2007	Kiev (UKR)
2006	Joensuu (FIN)
2005	Aichi (JAP)
2004	Västerås (SWE)


PRE
START
PRE
START

1st WTOC, Sweden, 2004



Specialities of trail-o maps

- This discipline is based on map reading skills, some countries it is called precision orienteering. The speed of moving is not relevant, but the speed of decision making is relevant.
- No need for separate trail-o map specification, sprint is adequate.
- The view of competitors is oblique (their route on the terrain is limited, viewing point) – take it into consideration in mapping and course setting.
- To remove all features from the maps which are invisible for the competitors from the tracks.

A new discipline: sprint (2001)

- The sprint format required a new, separate specification.
- The sprint events are regularly organized in urban environment (historical downtowns, parks) or in a mixture of different areas.
- The number of features is much higher in urban environment than in forest areas, but the minimum dimensions of mapped features are about the same: the running speed of competitors is regularly larger in sprint format, so they do not want to waste their time on looking for features which are not prominent on the terrain at full running speed.

WOC Summary

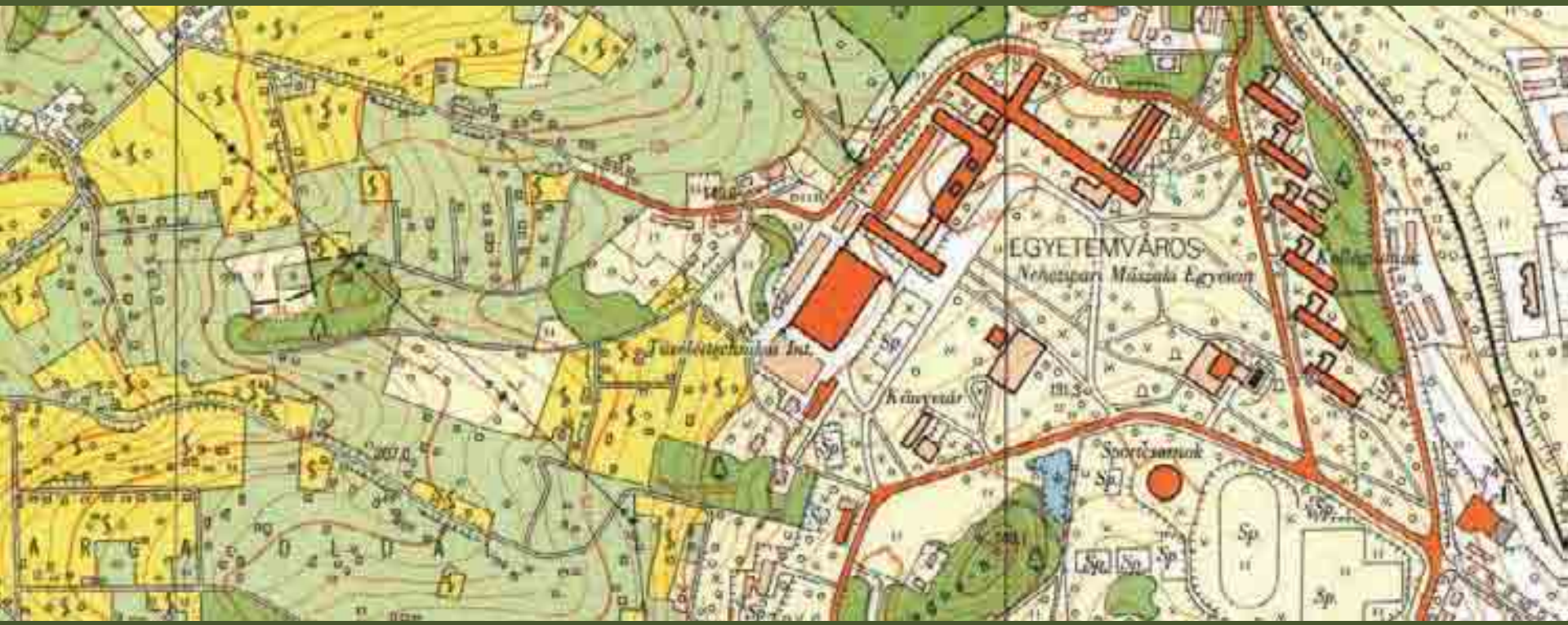
	FootO	MTBO	SkiO	TrailO
The first WOC	1966	2002	1975	2004
WOC frequency	1 year	1 year	2 years (odd)	1 year
WOC forms (2011)	• Sprint • Long • Middle • Relay	• Sprint • Long • Middle • Relay	• Sprint • Long • Middle • Relay • Mixed relay	• Open • Paralympic • Team • *TempO*
Countries (WOC)	53	27	28	21
Map specifications	ISOM (2000) ISSOM (2007)	ISMTBOM (2010)	ISSkiOM (2009)	ISSOM (2007)
Map scales	15000 (10000) *4000, 5000*	20000, 15000, *10000, 7500, 5000*	15000 (12500) 10000 (7500) *5000*	4000, 5000

Basemap alternatives for o-maps

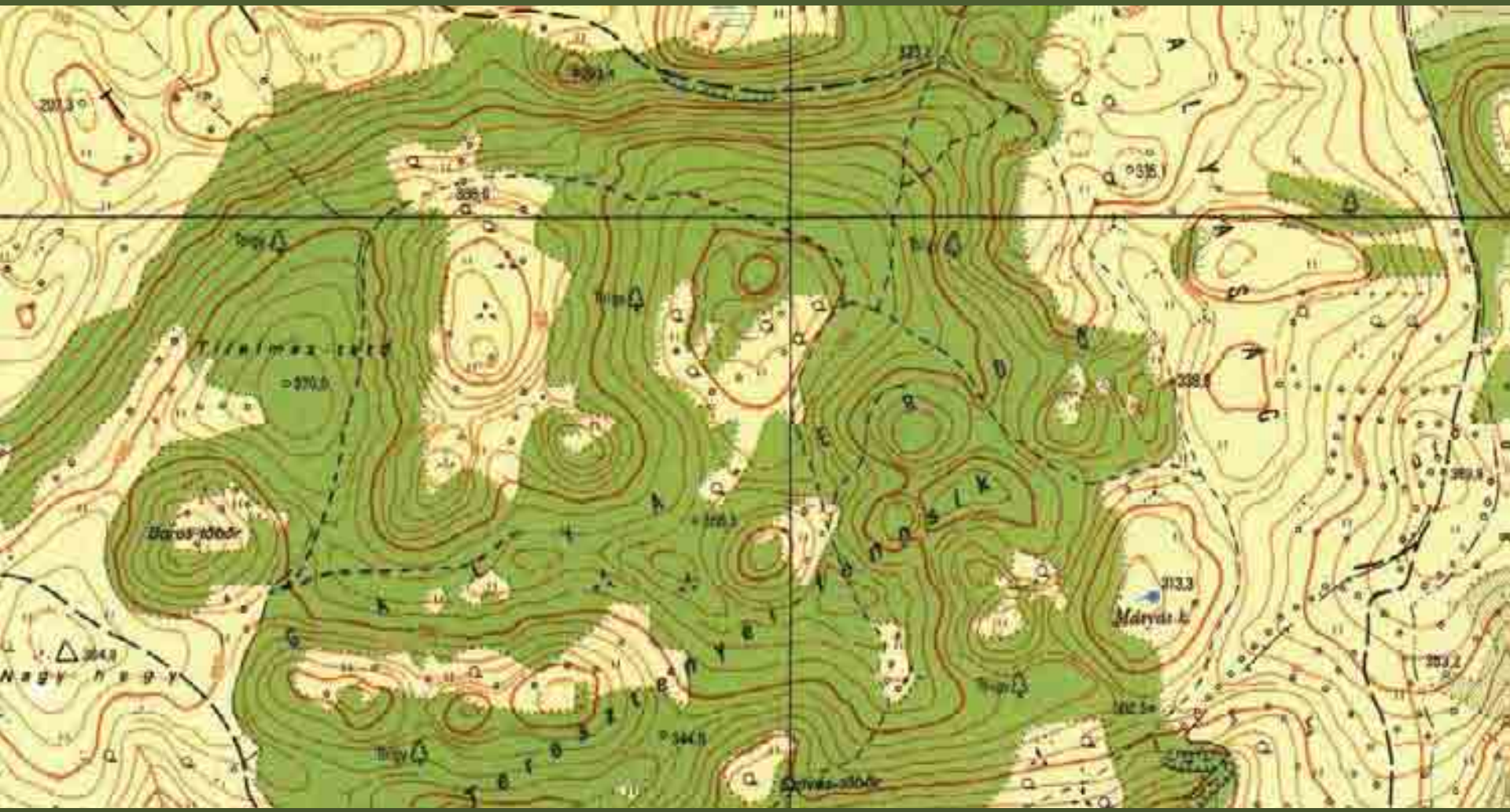
- Topographic maps
- Cadastral maps
- Aerial photos, orthophotos
- Special photogrammetric plots
- Old orienteering maps
- Laser Airborne Scanning
- GPS data

Basemap alternatives: Topographic maps

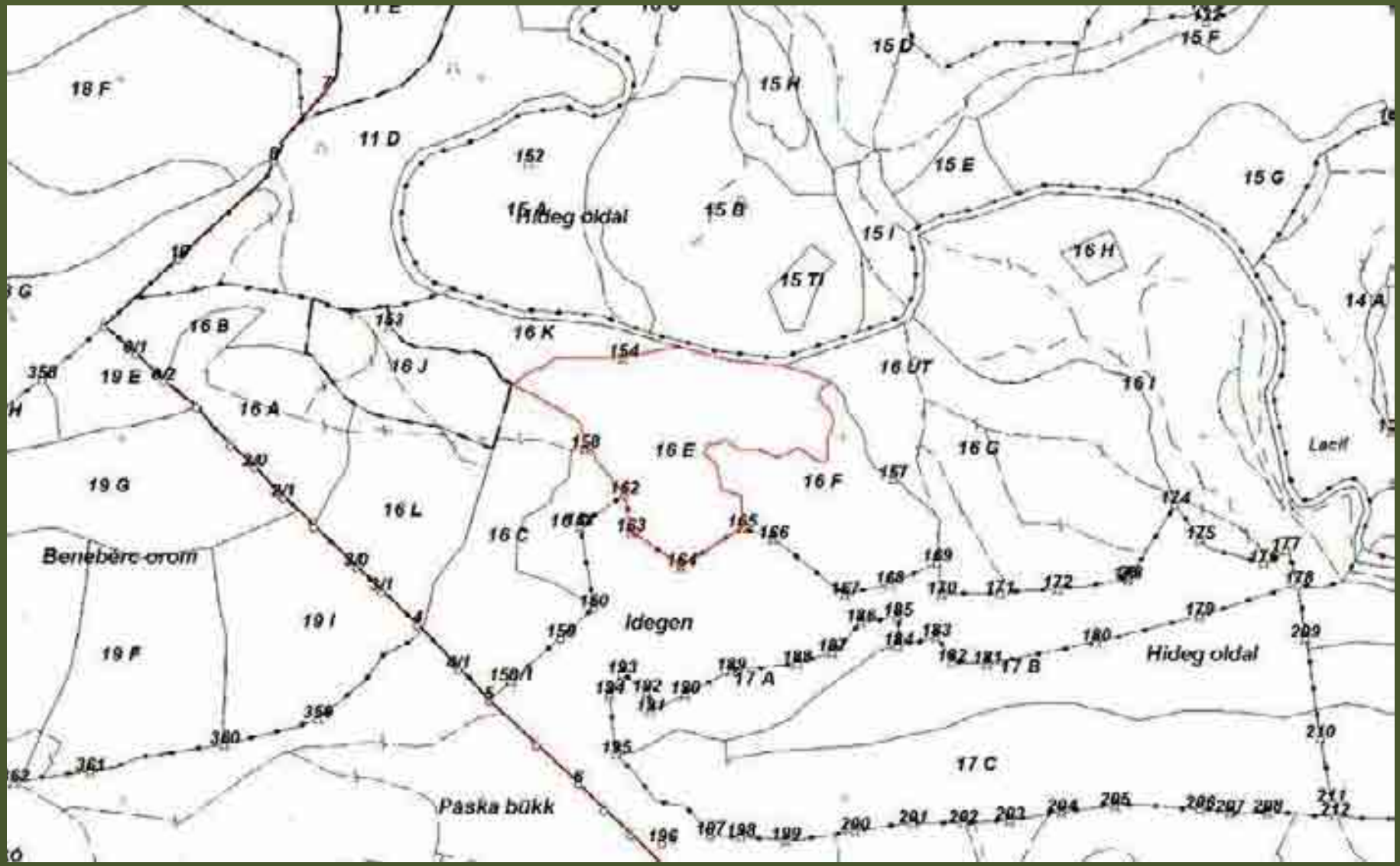
If a country is mapped at **1 : 10,000** scale or larger it is suitable for o-map basemaps (smaller scales are not detailed enough).



Basemap alternatives: Topographic maps

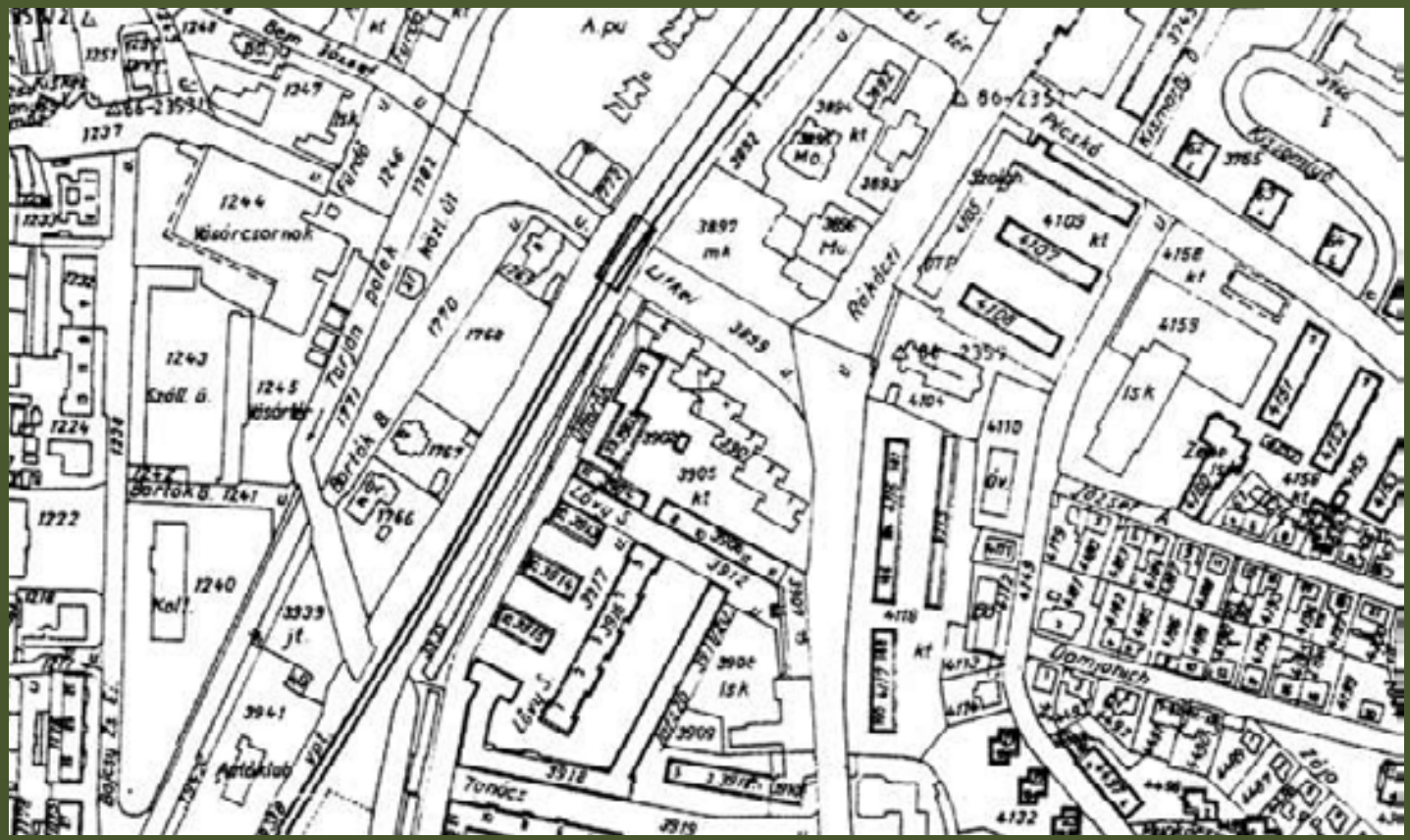


Basemap alternatives: Forestry maps



Basemap alternatives: Cadastral maps

The urban (built-in areas) are regularly mapped at 1:4000 or 1:2000 scale. These maps are appropriate for sprint maps, the only problem is that most of these maps are produced without contour lines.



Basemap alternatives: Aerial photos, orthophotos

In many countries they are easily available.
Limited details, sometimes difficult to interpret.

Orthophoto sample

Basemap alternatives: Special photogrammetric plots

Pro:

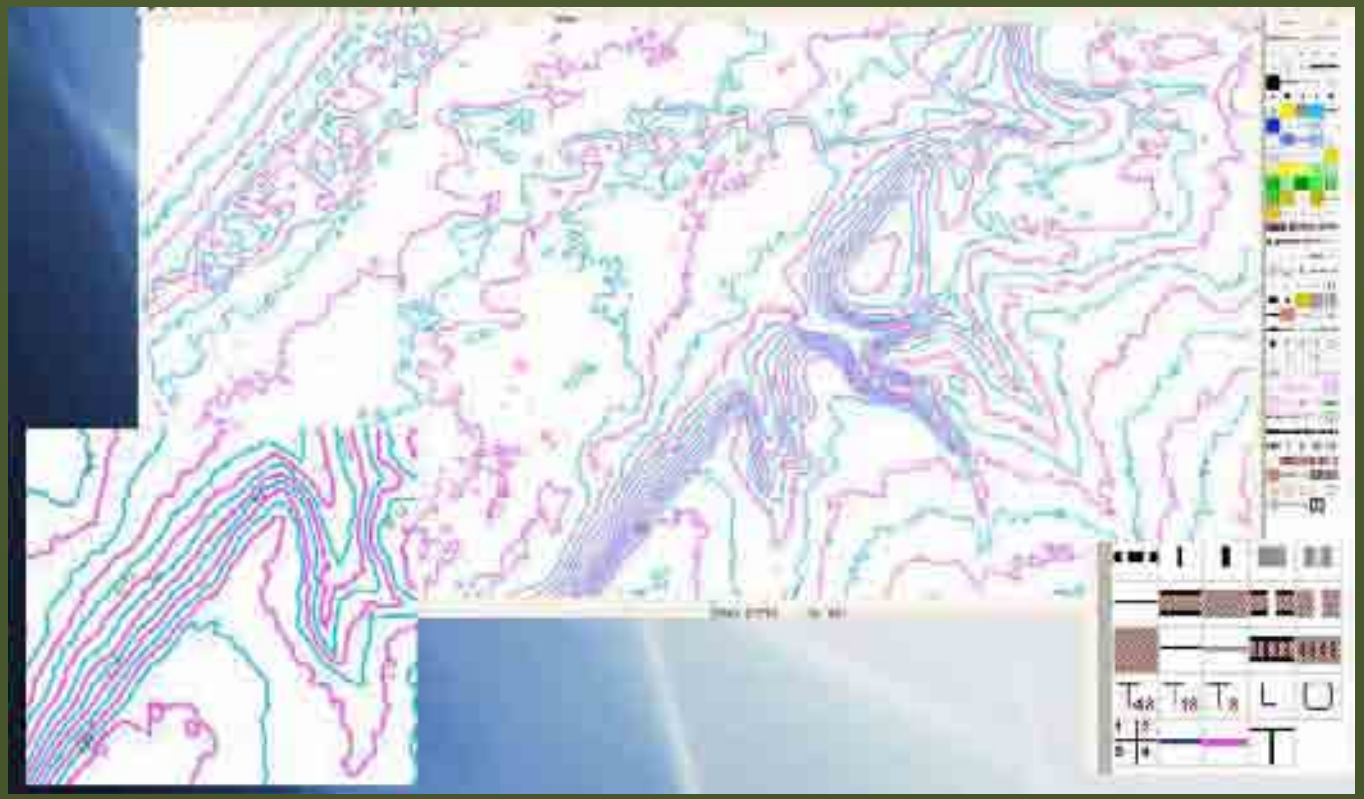
- Detailed contours plus additional information on other elements.
- Up-to-date.

Cons:

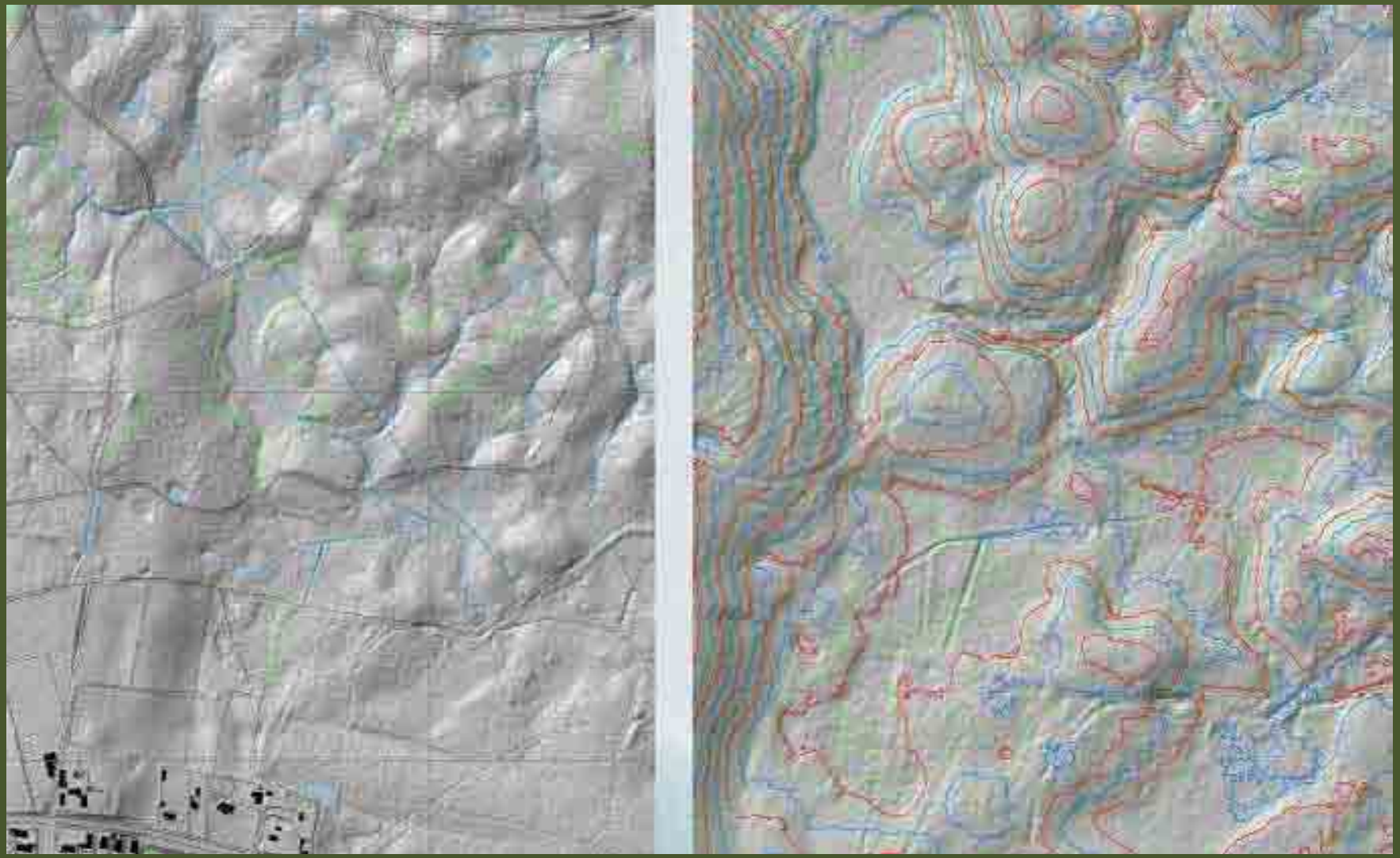
- Expensive.
- The available aerial photos sometimes not suitable, special flying is necessary.
- The outcome would not give enough details.

Basemap alternatives: Laser airborne scanning

This technology is in many countries. Where this data is easily available the mapping has changed: too many details > generalization requires good cartographic skills.



Basemap alternatives: Laser airborne scanning

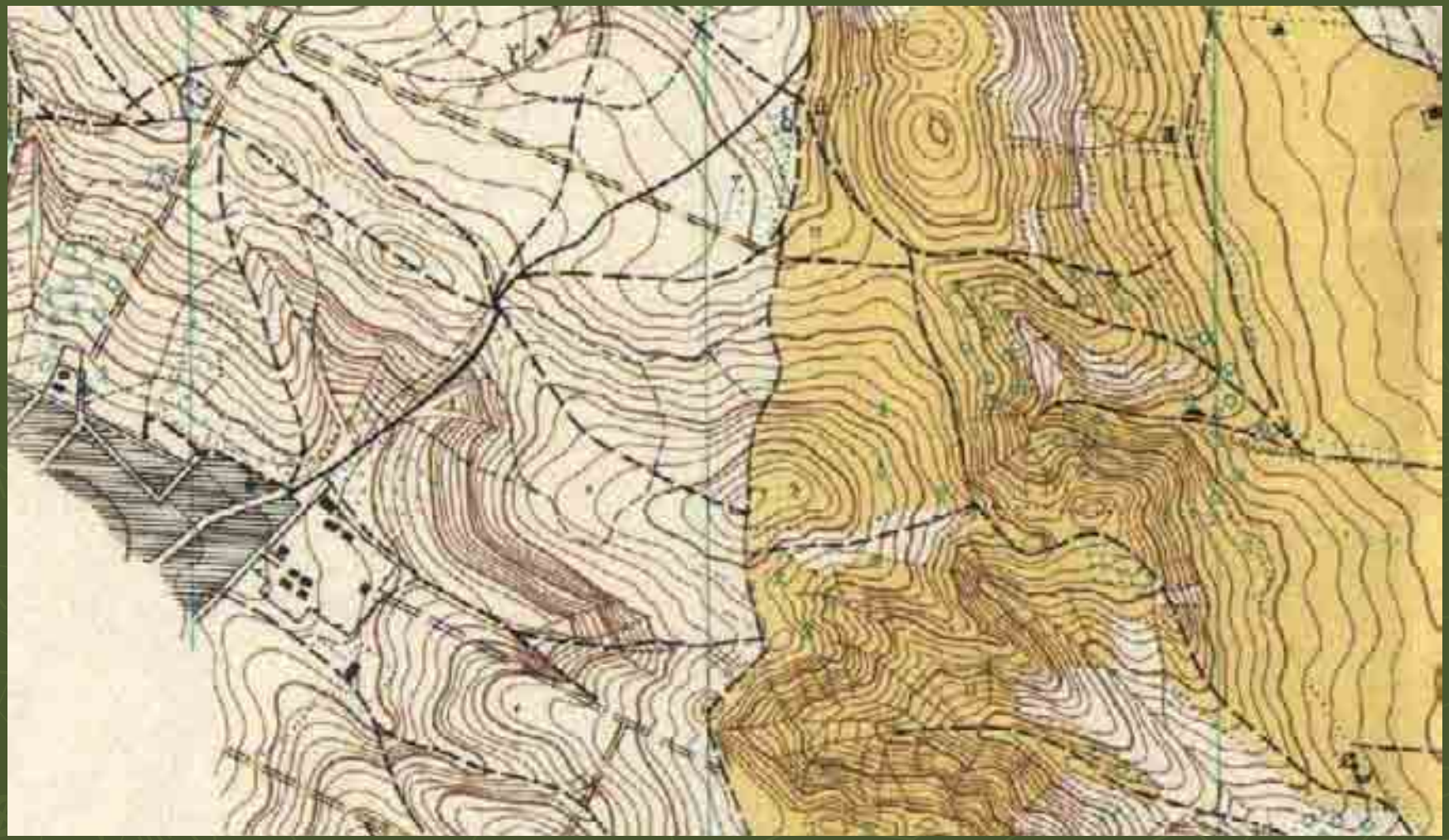


Basemap alternatives: GPS data

- Can help to map the road network if there are no other options/basemaps available.
- The efficient use requires expensive devices and technical knowledge.
- Postprocessing is necessary.

The development on maps

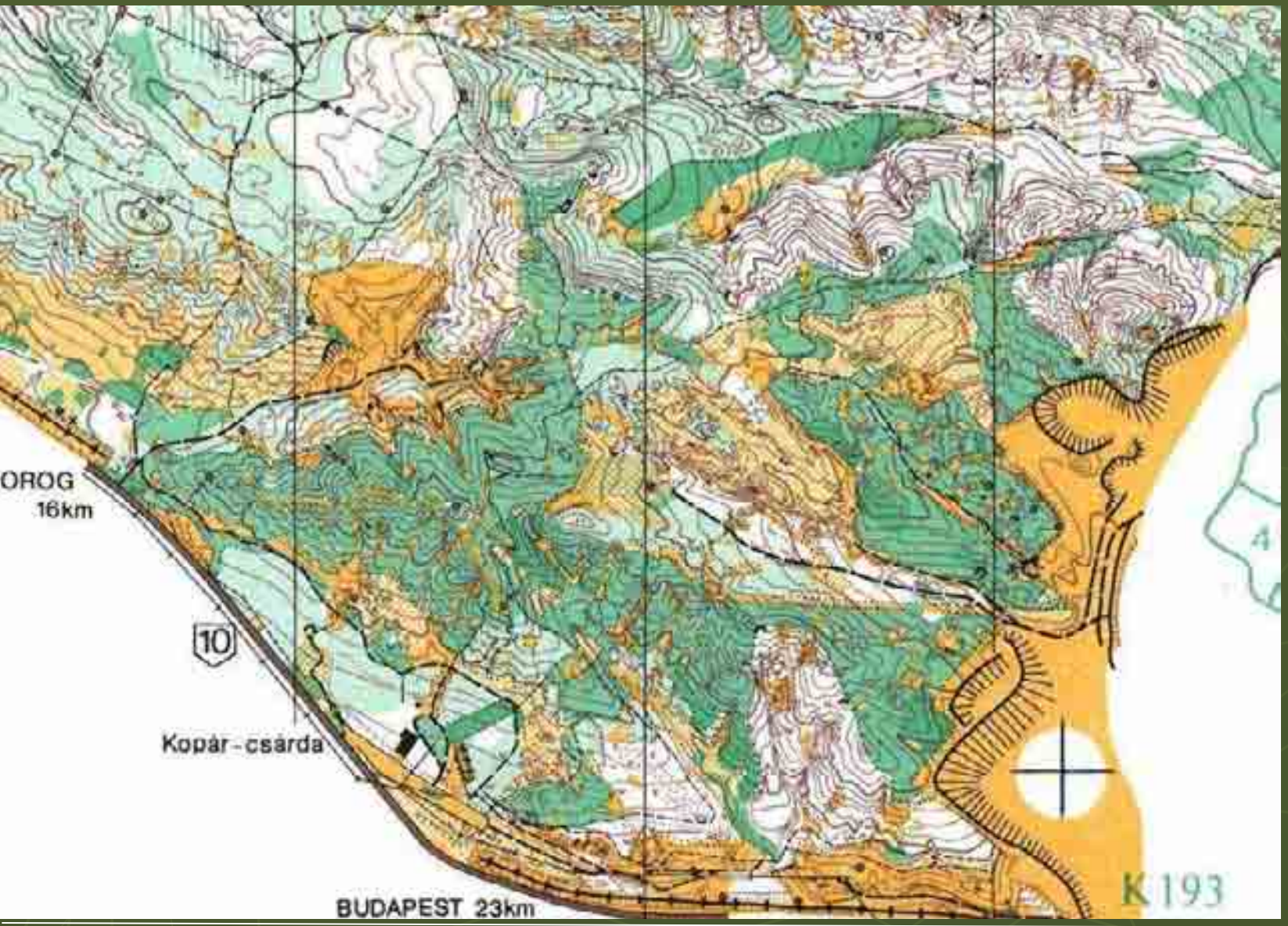
1968
1:25000



The development on maps

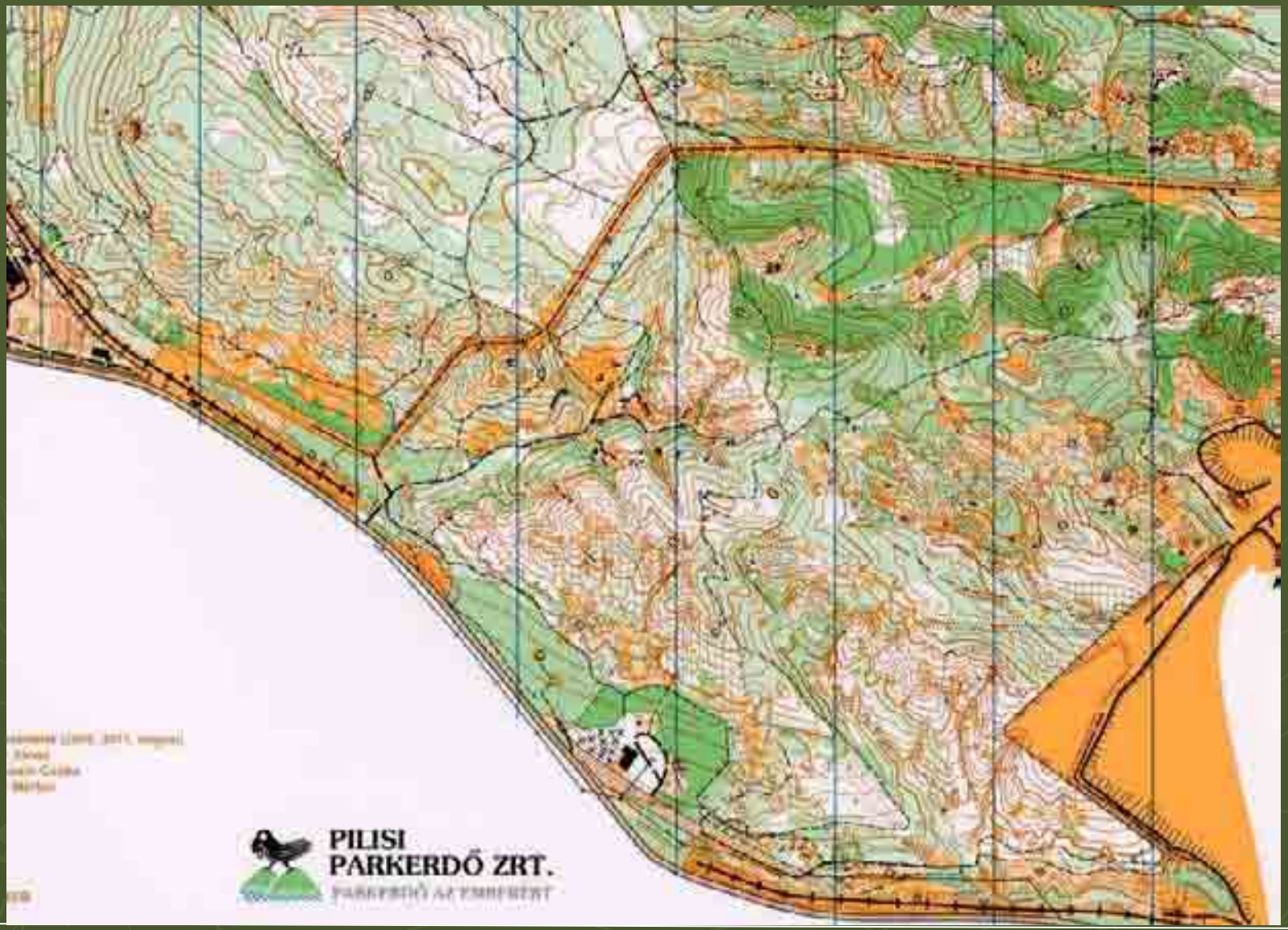
1978
1:20000

The development on maps



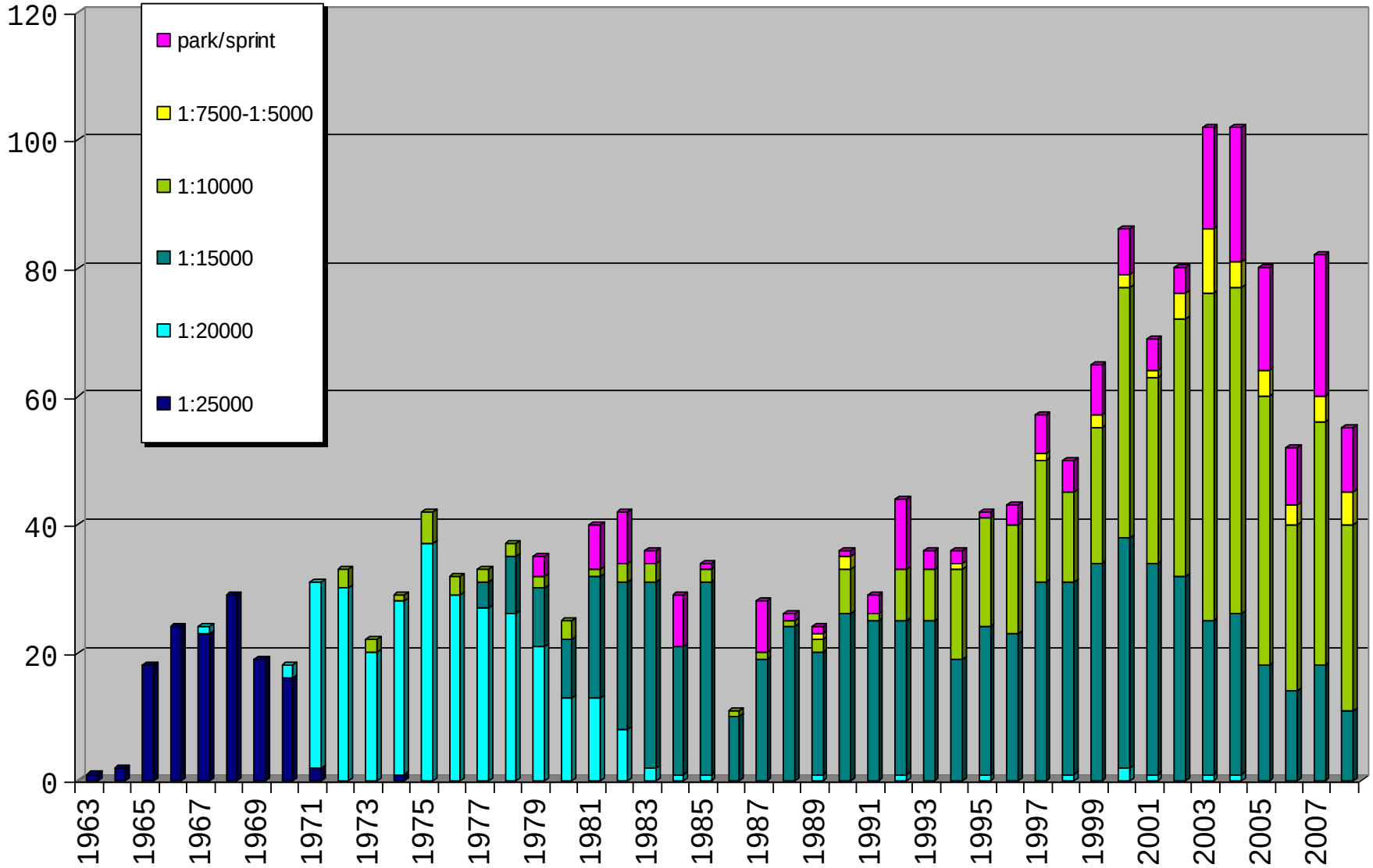
1991
1:15000

The development on maps



2011
1:10000

Hungarian o-map statistics (offset)



Why orienteering maps are so special?

- No text (except the title).
- Very large scale, lot of details not comparable to any other maps.
- Relative accuracy is more important than the absolute accuracy.
- Special map specification used internationally (no deviations).
- Maps are made practically by the users, by orienteers, not by cartographers. Cartographer may not familiar with the need of the orienteers, they have a different view of the terrain.
- Mapmaking means practical fieldwork, sometimes 30-40 hours/sq km.
- Special map drawing software: OCAD (very user-friendly), but the printing requires good technical skills.
- In most countries these maps are made totally outside of the „official” cartography, maps are not sold at all, not archived.

Orienteering today

- This year the IOF can reach the 75 member nations.
- In some years the number will be lower, the IOF had to implement qualitative criteria for the membership (based on the request of the International Olympic Committee). Member countries should organize national championships at least in one discipline.
- WOC2011-2012: More than 50 countries were present with competitors.
- Stable IOF event programme, but few events are organized outside Europe.
- Some countries are very professional (live tv coverage, GPS tracking)

Orienteering maps today

- We have well-established mapping standards in all disciplines (unified map specifications all over the World; practically part of the competition rules).
- New technologies are available:
  - Surveying techniques: laser scanning (LIDAR), UAV (un-manned aerial vehicles), GIS.
  - Printing technologies: digital printing, inkjet and laser printers, 3D printers.
  - New technologies can help us to produce more accurate maps, but without fieldwork orienteering maps can't be produced.
  - Generalization will be a key issue to keep the characteristics of the different forms of events (sprint, middle, long).
- Legibility!!!

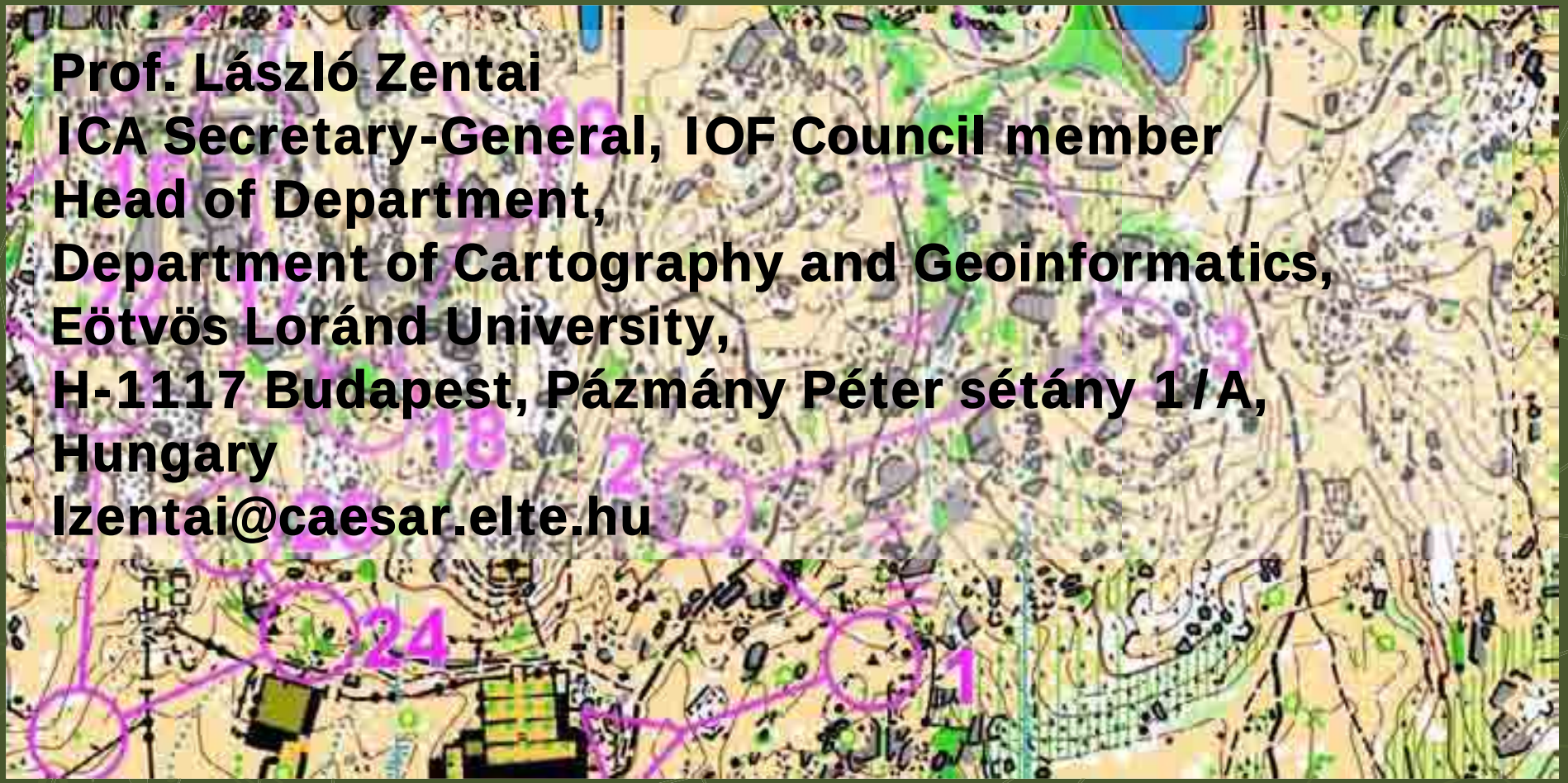
Conclusions

- The development of orienteering maps was a complex process, which was affected by various factors.
- It was mostly determined by financial and technical constrains, but political conditions were also present.
- Although the first civil event was organized in 1897, the development of orienteering maps in the first 40-50 years was very slow.
- The sport did not reach the level where the number of competitors made the organizers develop a special type of maps for orienteering.
- At that time, the orienteering sport used the maps that were available and suitable for the competitions: topographic maps, tourist maps.

Conclusions

- As the sport developed, established new formats and disciplines of these traditions were adjusted to the changing needs: like the higher speed of competitors in ski-orienteering and in MTBO.
- The most important changes occurred in the last 10–15 years: digital printing methods and laser scanning considerably affect the orienteering maps.
- New technologies give more support for the mapping (mostly for the fieldwork) and the main result of this is that mappers tend to add more details on the maps and finally the legibility is decreasing.
- The IOF and its responsible commissions are continuously working on keeping the characteristics of the different formats and the legibility is the most important factor on that.

Thank you for your attention



Prof. László Zentai
ICA Secretary-General, IOF Council member
Head of Department,
Department of Cartography and Geoinformatics,
Eötvös Loránd University,
H-1117 Budapest, Pázmány Péter sétány 1/A,
Hungary
lzentai@caesar.elte.hu