Standard Handbook v 1.0[1]

International Soil Judging Contest

(Dates)

(Location)

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Official Handbook of the (#) International Soil Judging Contest

(Dates)

(Location)

This handbook was compiled by the (#) IUSS International Soil Judging Working Group and the host nation organizers based on the IUSS Standard Handbook v.1.0 and the necessary adaptations for the (host nation) event.

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GENERAL INFORMATION

As part of the celebrations of the (#) World Congress of Soil Science, the (#) International Soil Judging Contest has been organized for (dates) in (location). The occasion is a great opportunity for students, researchers and people interested in soils from around the world to interact and experience some of the landscapes and soils of (host nation). The scope of the Soil Judging Contest is for participants to use their knowledge and practical skills to describe, understand, classify and interpret soil characteristics in the field. There are two contests: the group contest, where the whole team acts as a group, and the individual contest. Participants (in the form of groups and individuals) will describe a series of contest profiles using basic field tools, selected standards, and guidelines. The winners will be determined based on their ability to correctly describe each soil, denominate the layers, classify the soil, evaluate potential soil functions and interpret their capacity to perform under different land use and management practices. To prepare for the event, a four-day technical training course is offered that is compulsory for the participants.

The goals of this event are to give motivated students an opportunity to assess soils in a different part of the world, to give students an opportunity to develop networks in the soil science community, and to demonstrate the career opportunities that soil science offers. This event will also encourage the wider adoption of the discipline of soil judging around the world.

The (#) ISJC will consist of four days of practice on soil and landscape description, classification and interpretation, followed by one contest day. Each team will have an accompanying academic coach, who will assist participants in the field during the training days, but not during the contest day. The contest day will consist of description, classification and interpretation of two soil profiles and landscapes performed as a group and two soil profiles and landscapes performed individually.

Eligibility: A student must have been enrolled in a graduate program during the year of the contest or in an undergraduate program within one year prior to the contest. The teams are nominated by a national Soil Science Society. The members must be a national of the nominating country and/or a student of a university in the nominating country.

Soil Profiles: The profile pits should be at least 2 m wide and horizontally homogeneous. It must be easy to move in and out the profile pit. It is an advantage if they can be reached in short time from the accommodation. The profiles visited on one day should be close together but not so close that one can hear at one profile what is spoken at another one. An adequate place that can be used as a toilet must be available.

Training (4 days)

An international team of soil experts will give an overview of the site and profile description guidelines and soil classification standards. Local soil experts will introduce the landscape and soil conditions of (location), with a focus on the area of the contest. Short classroom sessions will be followed by practical training in field procedures and techniques. Standard samples will be provided for training in texture class and clay and sand percentage estimation. The soils in question will cover a diverse geographical area with a range of topographic, parent material and soil moisture regime conditions. The soils most commonly found in the (region name) region are (List WRB Reference Soil Groups) according to the World Reference Base of Soil Resources (WRB) and (List Soil Taxonomy Orders) according to Soil Taxonomy (ST).

The Contest (1 day)

Participants (groups and individuals) will describe and classify the contest profiles, based on the available field tools and selected standards and guidelines. Evaluation of potential soil functions and interpretation of the capacity of the soil to perform under different use and management will be also scored. The four contest soil profiles will be selected from soils similar to those seen during training.

Equipment and Reference Materials

The following equipment will be available to borrow from the pit monitor, but in a limited supply, we therefore encourage each team to bring their own.

Required for all contests:

- Soil knife/digging tool
- Magnifying glasses or hand lens
- Water bottle (extra water will be provided at each site)
- Clinometer
- Clipboard
- Munsell® Soil Color Chart
- Simple calculator (no functions other than calculating)

Optional:

- 2-mm sieve
- Hand towel

The teams are requested to bring their own Munsell® Soil Color Chart books, as only a limited number can be supplied by the organizers. The soil knife provided will be very small and simple, so we suggest the competitors to bring their own. HCl in dropper bottles and containers for soil samples (muffin bakers) will be provided by the organizers.

All the participants are encouraged to bring their own sunscreen, insect repellent, raincoat, boots, hat, and any other important personal items; none will be provided by the organizing team.

Besides this printed handbook, the Simplified WRB Diagnostics addendum, and the Simplified Keys to Soil Taxonomy addendum, the following printed reference materials will be permitted during the contest (but not provided by the organizing team):

- IUSS Working Group WRB. 2022. World Reference Base for Soil Resources, 4th edition https://wrb.isric.org/files/WRB_fourth_edition_2022-12-18_errata_correction_2024-09-24.pdf
- Switoniak M et al. 2022. Illustrated Handbook of WRB Soil Classification https://www.researchgate.net/publication/368839948_Illustrated_Handbook_of_WRB_Soil_Classification
- Soil Survey Staff. 2024. Field Book for Describing and Sampling Soils, Version 4.0 https://www.nrcs.usda.gov/sites/default/files/2025-01/Field-Book-for-Describing-and-Sampling-Soils-v4.pdf
- Soil Survey Staff. 2022: Keys to Soil Taxonomy, 13th Edition https://www.nrcs.usda.gov/sites/default/files/2022-09/Keys-to-Soil-Taxonomy.pdf
- Soil Survey Staff. 2015: The Illustrated Guide to Soil Taxonomy, Version 2.0 https://www.nrcs.usda.gov/sites/default/files/2022-06/Illustrated_Guide_to_Soil_Taxonomy.pdf

Older editions of these materials are not permitted. Additional reference materials may be developed by the IUSS Working Group on International Soil Judging Contests.

Conduct of the Training

A typical conduct of training can be like this: On the 1st day there will be classroom presentations on the soils of (host nation) as well as an introduction to important soil interpretations of soils in the region. After lunch there will be a field training. On the 2nd day training on soil classification will take place focusing on the diagnostic elements of the World Reference Base for Soil Resources (WRB) and Soil Taxonomy (ST). After lunch a field training will take place.

On the 3rd and 4th day, there will be a field training. Each day up to 4 profiles will be investigated (up to 2 in the morning and up to 2 in the afternoon).

In each pit, a typical section will be selected and clearly designated as the control section by the contest officials. A measuring tape will be placed in the control section and will be maintained by official pit monitors. The control section must be used for measurement of layer depths and boundaries; it will constitute the officially scored profile and must remain undisturbed and unblocked. Taking samples for studying soil characteristics is only allowed outside the control section. A **pitcard** at each site will give the profile depth to be considered, the number of layers to be described, and chemical or physical data that may be required for classification.

Every participant will receive 1 **scoresheet** per pit (for the group contest only 1 scoresheet per group). Following the instructions of organizers and coaches, the scoresheets are to be filled considering the laboratory information and the instructions of this handbook. Teams will be randomly assigned a team number at registration. Individual competitors will be assigned a number that will be used to identify their scoresheet and the rotation schedule. For every training pit, the team coaches will receive the full laboratory dataset and the already filled scoresheets that can be used for guidance.

Conduct of the Individual Contest

Seventy-five minutes will be allowed for evaluating each soil and site for individual judging.

The competitors will be randomly divided into two cohorts. At the first site, cohort 1 will follow this schedule:

1. 10 minutes in the pit,
2. 10 minutes out,
3. 15 minutes in,
4. 15 minutes out, and
5. 25 minutes free-for-all.

Cohort 2 will follow the opposite in-and-out schedule. At the second site, the cohorts will switch the in-and-out schedule, with cohort 2 in the pit first. Competitors may obtain a sample from the surface layer while out of the pit, as long as they do not enter the pit or disturb those already in the pit. These procedures may be altered prior to the contest to meet unanticipated difficulties at the site.

General rules of the individual contest:

- Competitors must use official codes found in this handbook;
- Competitors are not allowed to speak to each other;
- Competitors are not allowed to use mobile phones, tablets, PDAs or any communication device but may have them on hand in case of health emergency;
- Competitors may have health-related items with them during the contest (such as inhalers or allergy medicine);

- Competitors are allowed to use the equipment provided on site, and the allowed reference materials.
- Each competitor will describe two soil pits. The final score of each competitor will be the total of the two individual-judged pits. No scores are dropped.

Conduct of the Group Contest

Seventy-five minutes will be allowed for evaluating each soil and site for group judging. The time will be divided into segments similar to the individual contest. Groups that start in at the first pit will start out at the next pit. All competitors of each group may participate in the group contest.

General rules of the group contest are the same as of the individual contest, with these exceptions:

- Group members are allowed to speak to other group members (only within the group), as long as their conversation is not loud enough to be heard by other groups;
- Each group will describe two soil pits. The final result for the group contest will be the total of the two group-judged pits. No scores are dropped.

Overall Team Score

For the overall team score only the best three scores at each individually judged pit will be considered for the team final score (this is done so a team of three students can compete). If a team has four members then the lowest score at each pit is dropped. Both group-judged pit scores will count. The final overall team score will consist of the top six individual scores plus the two group scores.

Code of Conduct for the Contest

The host and the IUSS are committed to providing a safe, educational, and productive environment for everyone present at the Soil Judging Contest and therefore prohibit intimidating, threatening, or harassing conduct during the soil judging event. This policy applies to everyone associated with the contest. Participants violating these rules may be asked to leave the meeting at the discretion of contest administrators. Harassment of any kind is a serious issue, will not be tolerated in any form, and includes the following: Offensive comments related to race, ethnicity, religion, disability, age, economic status, physical appearance, gender, or sexual orientation. Deliberate intimidation, stalking, following, unsolicited and harassing photography or recording, sustained disruption of talks or other events, inappropriate physical contact, and unwelcome attention, or any other activity deemed to be harassing will not be tolerated. Participants asked to stop any harassing behavior are expected to comply immediately. If you are being harassed, notice someone else being harassed, or have any other concerns, please contact the contest host who will work with the appropriate leadership to resolve the situation.

1 SITE DESCRIPTION

Task on the scoresheet: Record the profile ID, contestant ID, the number of layers to describe, the bottom depth of the description, and the depth of the nail(s) and the layer number(s) at the bottom of which the nail is/nails are placed. This information will be provided on the pitcard. Additional data will include: lab data as needed, flooding or ponding frequency, information about cracks, and presence of heavy metals, pollutants, or pesticides in the soil.

1.1 Land Use

Task on the scoresheet: Indicate the land use type according to Table 1.

Table 1. Land use type (IUSS Working Group WRB, 2022, Table 8.9, modified)

Land-use type	Code
Perennial crop production (e.g. food, fodder, fuel, fiber, ornamental plants)	CPP
Annual crop production (e.g. food, fodder, fuel, fiber, ornamental plants)	CPA
Fallow, less than 12 months, with spontaneous vegetation	FYO
Fallow, at least 12 months, with spontaneous vegetation	FOL
Fallow, all plants constantly removed (dry farming)	FDF
Pasture on unmanaged vegetation	GNP
Intensively managed grassland, pastured	GIP
Intensively managed grassland, not pastured	GIN
Forestry	FOR
Simultaneous agroforestry system	AFS
Nature protection	NPR
Settlement, industry	SEI
Military area	MAR
Other land uses (specified by the contest host)	OLU
Not used and not managed	∅

1.2 Landform

Task on the scoresheet: Determine the landform type based on *Table 2*. Some landform choices are shown in *Figure 1*, *Figure 2*, and *Figure **3***. A topographic map with the pit location marked may also be provided.

Table 2. Landform types

Landform	Code
Floodplain (alluvium; low lying area that floods, minimal soil development)	FP
Stream Terrace (alluvium in some part; rarely or non-flooded areas, former floodplains)	ST
Alluvial Fans (alluvium; cone-shaped deposit at tail of steep drainageway)	AF
Drainageway (any parent material; sloping concave area carrying runoff briefly after rains to lower floodplains)	DQ
Anthropogenic (human-transported material deposit or an excavated area)	AN
Upland (none of the other choices)	UP

1.3 Slope Position

Task on the scoresheet: Determine the position according to *Figure 1*, *Figure 2*, and *Figure 3*. Use the codes indicated in *Table 3.* Slope stakes will be placed on the same landscape position as the pit whenever possible. The area of the slope stakes should be used to determine slope position.

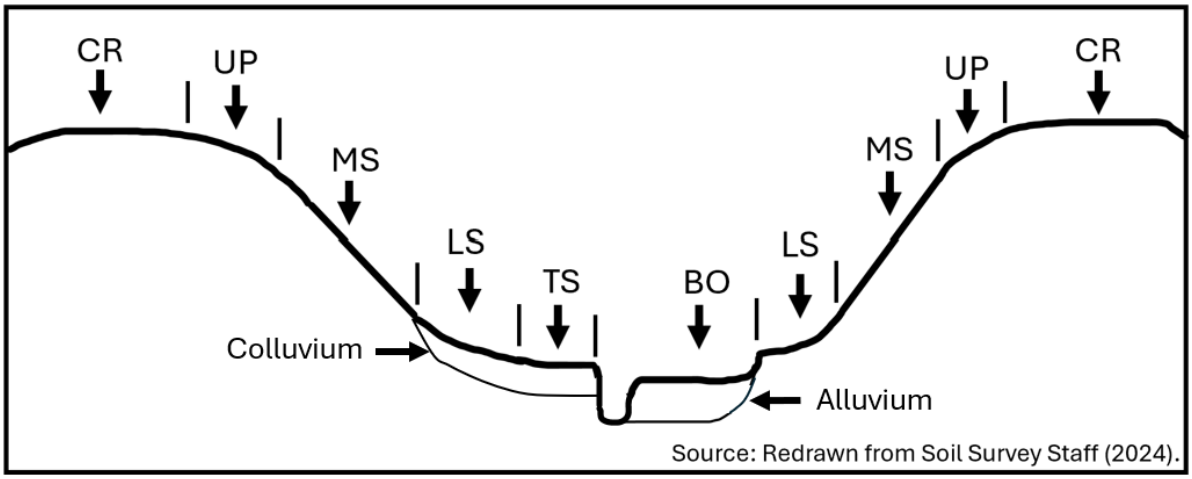

Figure 1. Slope position in undulating and mountainous terrain (Soil Survey Staff, 2024, 1-7, modified)

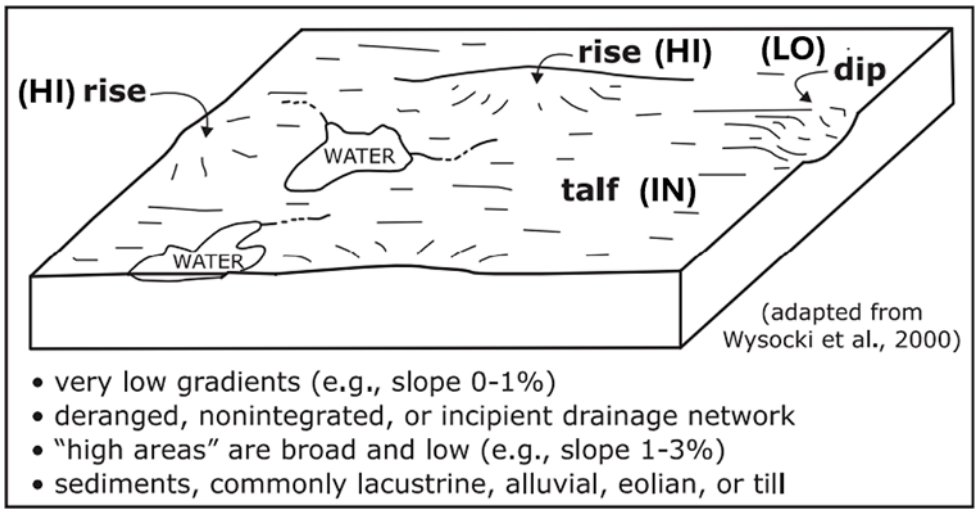

Figure 2. Slope position in flat/almost flat terrain (Soil Survey Staff, 2024, 1-9)

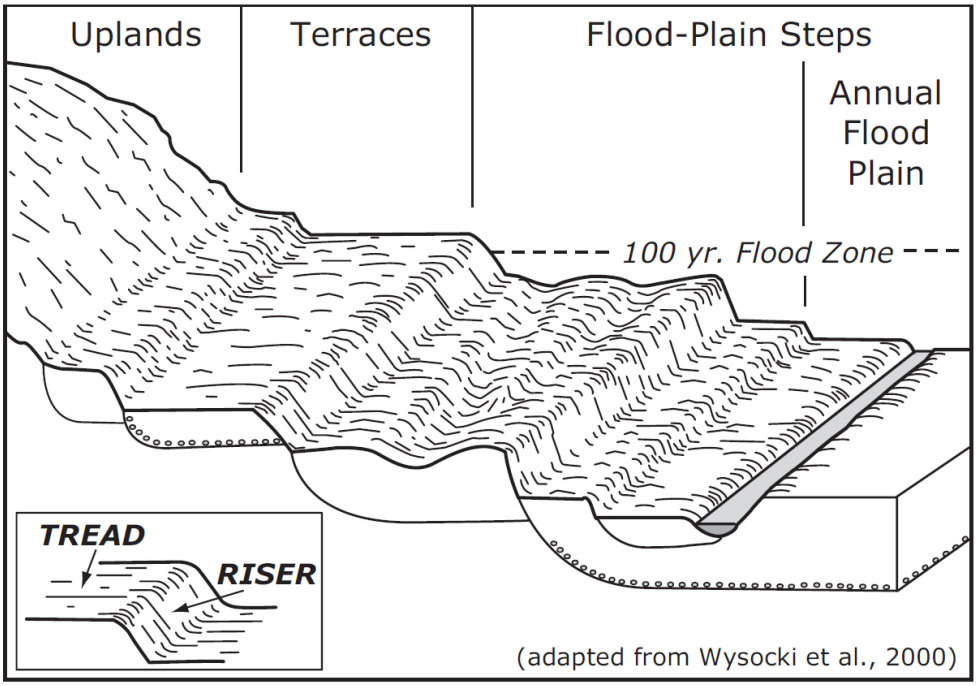

Figure 3. Slope position on natural or human-made terraces/stepped terrain (Soil Survey Staff, 2024, 1-8)

Table 3. Slope position in various terrains (IUSS Working Group WRB, 2022, Table 8.1; Soil Survey Staff, 2024, 1-6 to 1-9)

Position in undulating/mountainous terrain		**Position in flat/almost flat terrain**	
Landform	Code	Landform	Code
Crest (summit)	CR	Higher part (rise)	HI
Upper slope (shoulder)	UP	Intermediate (talf)	IN
Middle slope (backslope)	MS	Lower part (dip)	LO
Lower slope (foot slope)	LS	Bottom (floodplain)	BO
Toe slope	TS		
Bottom (floodplain)	BO		
Position on terraces or stepped terrain			
Landform			Code
Riser (sloping ground between treads)			RE
Tread (flat terrace surface)			TR

1.4 Slope Gradient

Task on the scoresheet: Determine the slope gradient as a percentage. Slope stakes will be placed on the same landscape position as the pit.

1.5 Rock Outcrops and Surface Rock Fragments

Task on the scoresheet: Estimate on the soil surface the percent of the surface area of rock outcrops and larger rock fragments (also called larger coarse fragments, see Section 2.3), both with a diameter > 2 cm. Competitors can refer to the percentage charts of *Section 10*. An area for evaluation will be marked.

1.6 Human-Made Surface Unevenness

Task on the scoresheet: Report the type of human-made surface unevenness with an average height difference of ≥ 5 cm (*Table 4*). Report only if it shows a repeating pattern of two or more. An area for evaluation will be designated by the contest host or indicated on the pitcard.

Table 4. Human-made surface unevenness (IUSS Working Group WRB, 2022, Table 8.20, modified)

Type	Code
Human-made terraces	HT
Drainage canals	CD
Irrigation canals	CI
None	∅

1.7 Litter Layer

Task on the scoresheet: Report the percentage of the area covered by a litter layer and the average thickness of the litter layer in cm. Competitors can refer to the percentage charts of *Section 10*. An area for evaluation will be marked.

A litter layer (WRB) or a layer of freshly fallen plant litter (ST) is a loose layer that contains > 90% (by volume, related to the fine earth plus all dead plant residues) recognizable dead plant tissues (e.g. undecomposed leaves). The soil surface (0 cm) is by convention the surface of the soil after removing, if present, the litter layer. The mineral soil surface is the upper limit of the uppermost layer consisting of mineral material (WRB) or mineral soil material (ST) (see Section 2, General Definitions).

2 SOIL DESCRIPTION

General Definitions

1. The fine earth comprises the soil constituents ≤ 2 mm. The natural mineral constituents > 2 mm are called rock fragments (coarse fragments). The whole soil comprises fine earth, rock fragments, artefacts, cemented parts and dead plant residues of any size.
2. In both systems (WRB and ST), a soil layer is a horizontal zone in the soil, approximately parallel to the soil surface, with properties different from layers above and/or below it. In ST, the terms layer and horizon are used interchangeably. In WRB, the term soil layer comprises all horizontal zones, whether or not they underwent soil-forming processes. For simplification, in the following, we will use the word layer for horizontal zones and the word horizon when referring to diagnostic zones comprising one or more layers (e.g., argic horizon).
3. Organic material in WRB has ≥ 20% (by mass) organic carbon. Organic soil material in ST has ≥ 12% (by mass) organic carbon. The carbon contents or mineral material (WRB) and mineral soil material (ST) are below these limit values.
4. For some characteristics, concentrations (accumulations) must be reported. The definitions are given in *Table **5***.

Table 5. Types of concentrations (IUSS Working Group WRB, 2022, Table 8.51)

Description	Designation
Rounded body, at least very weakly cemented, that can be removed as discrete unit, with internal organization in the form of concentric layers visible to the naked eye	Concretion
Rounded body, at least very weakly cemented, that can be removed as discrete unit, without evident internal organization	Nodule
Longitudinal body of any cementation class	Filament
Non-cemented or extremely weakly cemented body of variable shape that cannot be removed as discrete unit	Mass
Covering the surfaces of coarse fragments, remnants of a broken-up cemented layers, aggregates or pore walls	Coating

Description Procedure

The minimum thickness of any layer to be described in this contest is 5 cm for an A or E layer, 2.5 cm for a Bh, Bsh, Bhs, or Bs layer, 1 cm for a pedogenetically-cemented layer or for a layer with ≥ 12% organic carbon, and 10 cm for all others. If a bedrock layer is present, the organizers try to expose it for at least 10 cm. If there are thinner layers to be described, it will be indicated on the **pitcard**.

The following characteristics in Section *2* must be completed for each mineral layer. Only the layer boundaries, rock fragments and artefacts, and carbonates must be described for both organic and mineral layers. Sampling of organic layers should be kept to a minimum (egg-sized), especially for very thin layers. For the decision, which tasks must be completed, the ST definition of organic/mineral layers is used.

2.1 Layer Boundaries

Task on the scoresheet: Determine the *depth (cm)* from the soil surface to the lower boundary of each layer. Determine the *distinctness* of the layer boundaries according to *Table 6* and the *shape* (*topography)*

of the layer boundaries according to *Table 6* and *Figure 4*. *Distinctness* and *shape (topography)* are not described for the lowest layer.

Table 6. Layer boundaries by distinctness and shape (IUSS Working Group WRB, 2022, tables 8.30 and 8.31, modified)

Distinctness			Shape (topography)		
Transition within (cm)	Class	Code	Determination	Class	Code
≤ 2	Abrupt	A	Nearly plane surface	Smooth	S
> 2 to 5	Clear	C	Pockets less deep than wide	Wavy	W
> 5 to 15	Gradual	G	Pockets more deep than wide	Irregular	I
> 15	Diffuse	D	Discontinuous	Broken	B

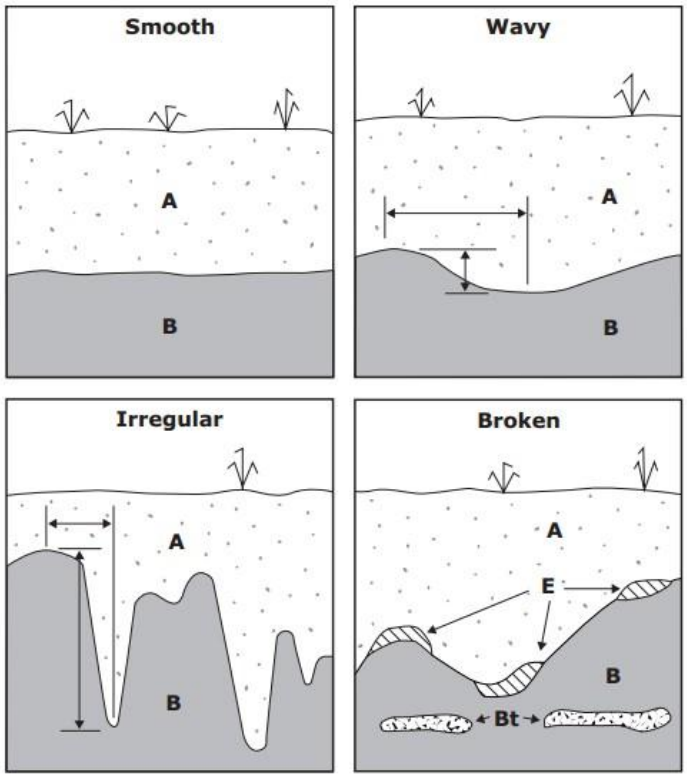

Figure 4. Shape (topography) of layer boundaries (Soil Survey Staff, 2024, 2-7)

2.2 Texture

Task on the scoresheet: Determine the texture class of the fine earth (≤ 2 mm) for each mineral layer using the texture triangle and the codes indicated there (*Figure 5*). You may use the provided flow chart (*Figure 6*) or any other scheme for determining texture. In addition to the texture class, a field estimate of the percentage of clay and sand must be given. This estimate is useful for indicating increases or decreases in clay and/or sand content within texture classes, and for comparing field estimates with analytical results.

In different countries, different limit values for particle-size classes and different texture triangles are used. This contest uses the definitions of WRB and ST (*Table 7*). The limit values for differentiating sand and silt are slightly different between the two systems, but this should not have a significant effect on hand texturing.

Table 7. Particle-size classes according to Soil Taxonomy (Soil Survey Staff, 2022) and WRB (IUSS Working Group WRB, 2022)

Particle-size class	Soil Taxonomy	WRB
Sand	> 50 µm - ≤ 2 mm	> 63 µm - ≤ 2 mm
Silt	> 2 µm - ≤ 50 µm	> 2 µm - ≤ 63 µm
Clay	≤ 2 µm	≤ 2 µm

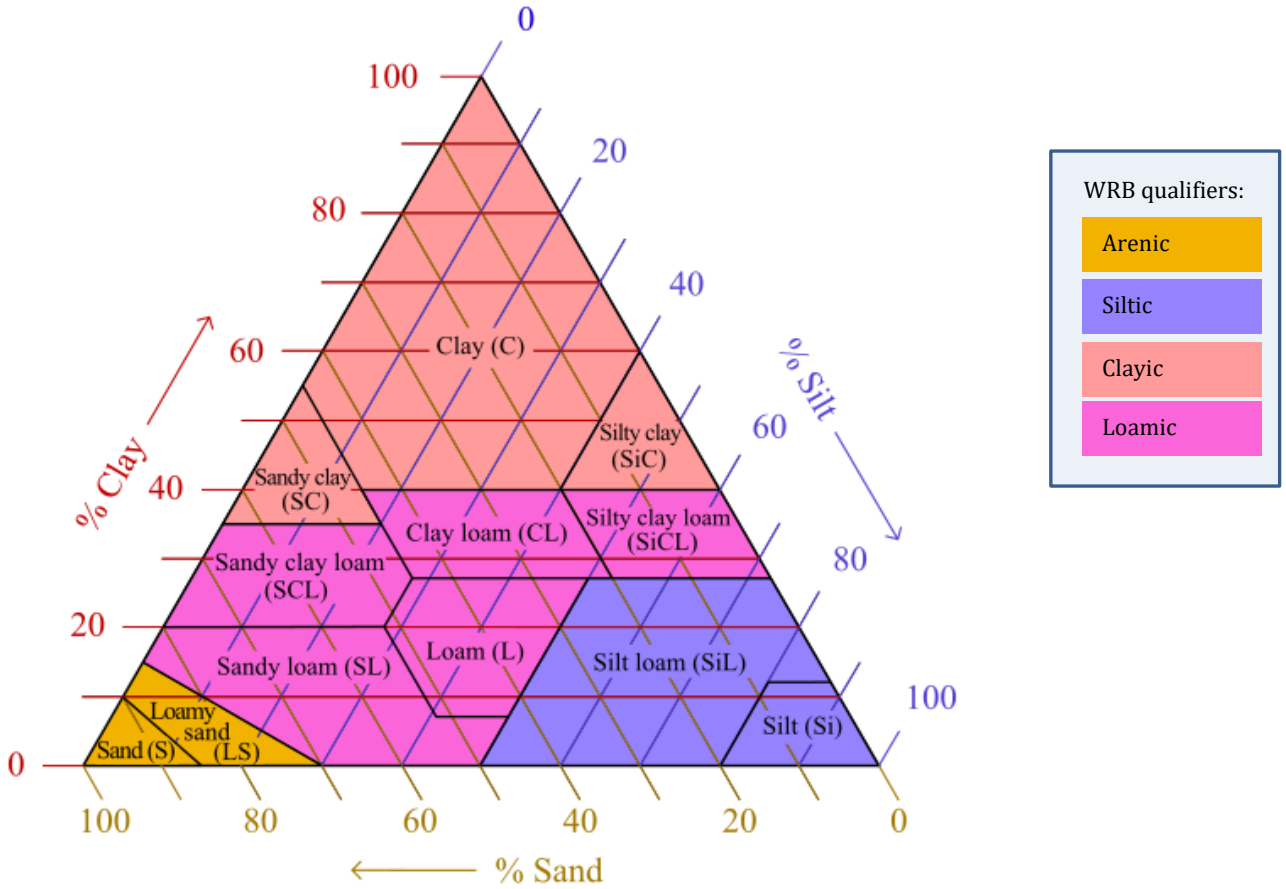

Figure 5. Texture classes with codes and with the correlation with the WRB texture qualifiers (IUSS Working Group WRB, Figure 8.13)

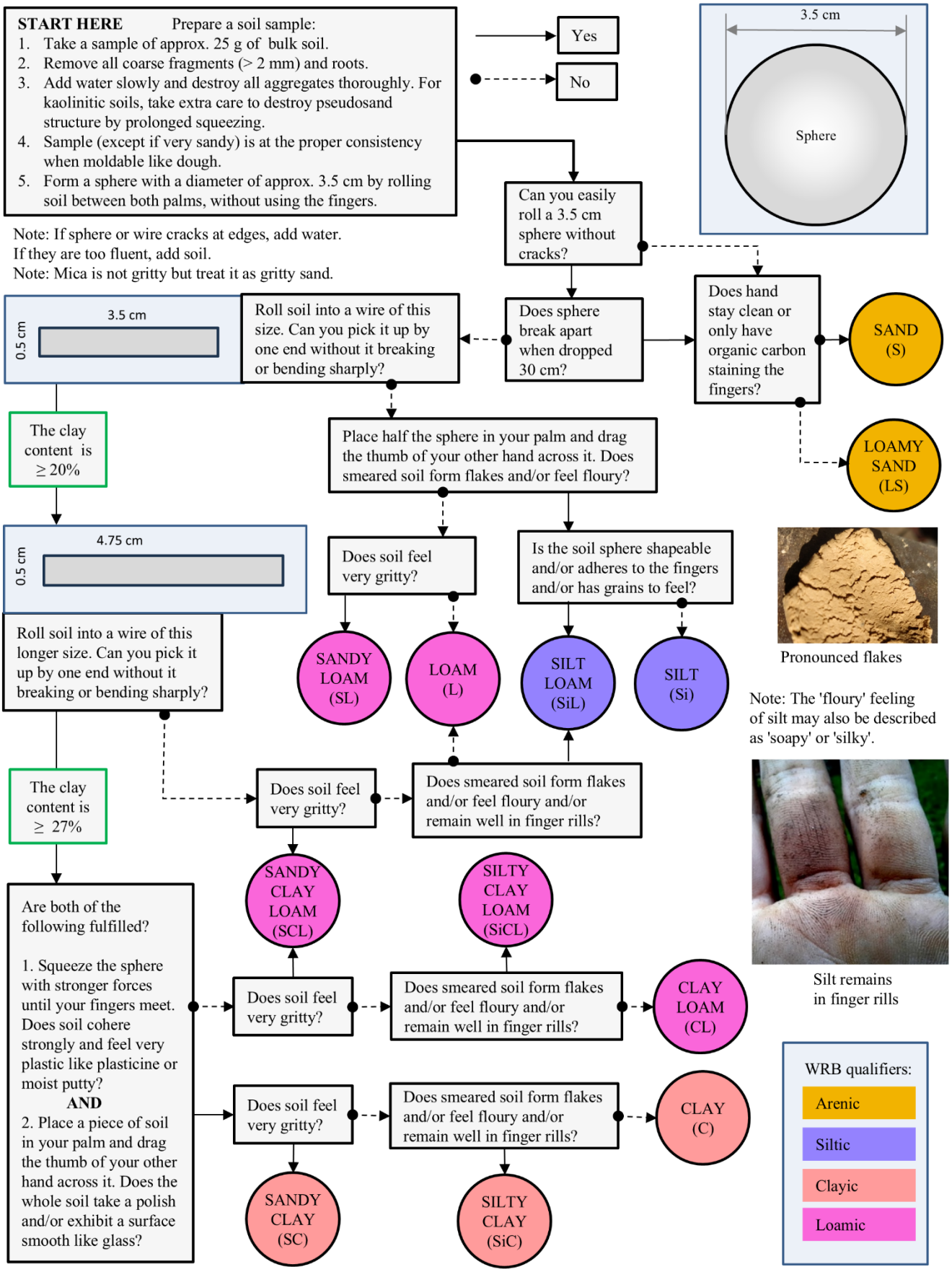

Figure 6. Flow chart for determination of texture classes (IUSS Working Group WRB, Figure 8.14, modified)

2.3 Rock Fragments and Artefacts (R.F./AF)

Task on the scoresheet: Estimate the abundance of rock fragments (also called coarse fragments) by volume in % for each layer. Rock fragments are unattached pieces of geologic origin that do not fail under foot pressure by full body weight. Competitors can refer to the percentage charts of *Section 10* for estimating percentages. If artefacts > 2 mm are present, they are included in this estimation. After estimating the abundance for every layer, a weighted average must be calculated from the mineral soil surface to 100 cm or to continuous rock or to a cemented layer with cementation class of at least moderately cemented, whichever is shallower. Information about cementation will be given on the pitcard, where necessary.

2.4 Structure

Task on the scoresheet: Record the dominant structure type for each mineral layer using *Table 8* and *Figure 7*. Record the dominant structure grade for each layer using the codes indicated in *Table 9*. If the structure type is SGR, MA, STR or CDY, the structure grade must be ∅.

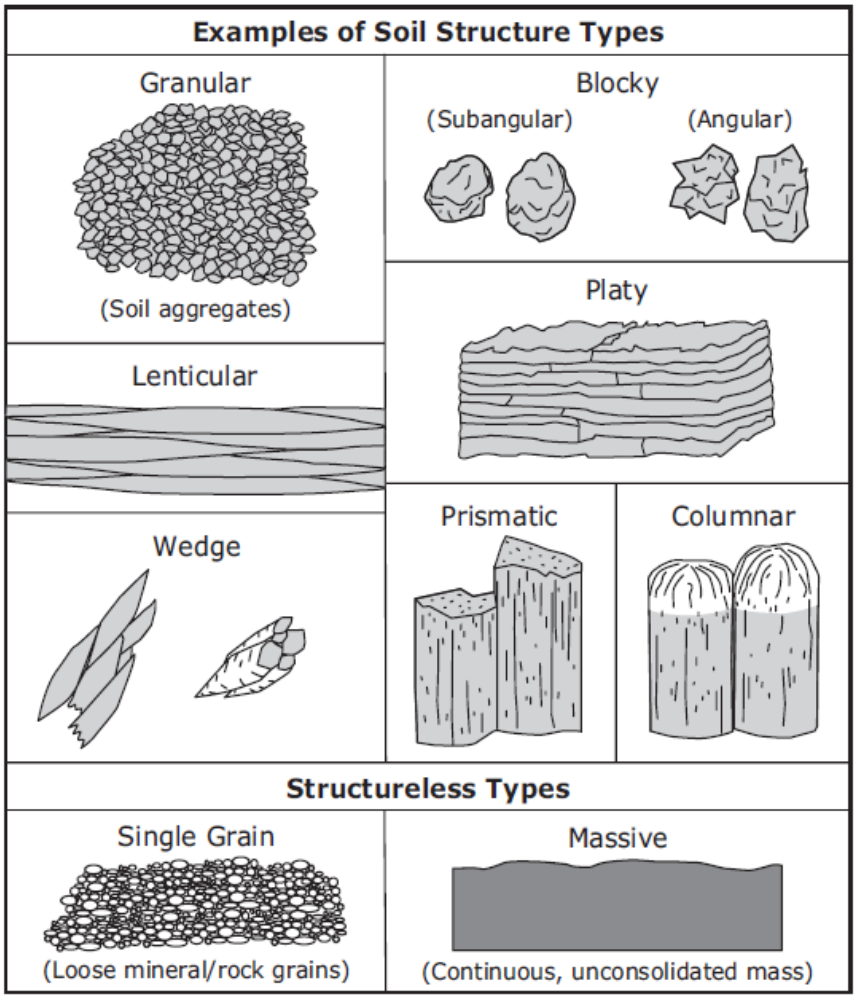

Figure 7. Examples of soil structure types (Soil Survey Staff, 2024, 2-54)

Table 8. Soil structure types (Soil Survey Staff, 2024, 2-53, modified)

Type	Determination	Code
NATURAL SOIL STRUCTURAL UNITS (pedogenic structure)		
Granular	Small polyhedrals with curved or very irregular faces.	GR
Angular blocky	Polyhedrals with faces that intersect at sharp angles (planes).	ABK
Subangular blocky	Polyhedrals with subrounded and planar faces lacking sharp angles.	SBK
Platy	Flat and platelike units.	PL
Wedge	Elliptical, interlocking lenses that terminate in acute angles.	WEG
Prismatic	Vertically elongated units; flat tops.	PR
Columnar	Vertically elongated units with rounded tops that commonly are "bleached."	COL
STRUCTURELESS		
Single grain	No structural units; entirely noncoherent; e.g., loose sand.	SGR
Massive	No structural units; material is a coherent mass (not necessarily cemented).	MA
Stratified	No structural units; visible stratification from sedimentation	STR
ARTIFICIAL SOIL FRAGMENTS OR CLODS (nonpedogenic structure)		
Cloddy	Irregular blocks created by artificial disturbance; e.g., tillage or compaction.	CDY

Table 9. Grades of aggregates (IUSS Working Group WRB, Table 8.43, modified)

Determination	Grade	Code
Aggregates are barely observable in place, and there is only a weak arrangement of natural surfaces of weakness. When gently disturbed, the soil material breaks into a mixture of few entire aggregates, many broken aggregates, and much loose material that is not in aggregates. Aggregate surfaces differ in some way from aggregate interiors.	Weak	WE
Aggregates are observable in place, and there is a distinct arrangement of natural surfaces of weakness. When disturbed, the soil material breaks into a mixture of many entire aggregates, some broken aggregates, and little loose material that is not in aggregates. Aggregate surfaces generally show distinct differences with aggregate interiors.	Moderate	MO
Aggregates are clearly observable in place, and there is a prominent arrangement of natural surfaces of weakness. When disturbed, the soil material breaks mainly into entire aggregates. Aggregate surfaces generally differ markedly from aggregate interiors.	Strong	ST

2.5 Soil Color

Task on the scoresheet: Use the Munsell® color chart to determine the dominant color, moist, of each mineral layer. Colors must be designated by Hue, Value and Chroma.

Take a fresh sample, slightly crush it and observe the color in the shade (both your eyes and the color chart in the shade). The moist state corresponds to field capacity, which is obtained with sufficient accuracy by moistening and reading the color as soon as visible moisture films have disappeared.

2.6 Carbonates

Task on the scoresheet: Estimate the $CaCO_3$ content of the fine earth of each layer adding some drops of 10% HCl to the soil. Use the codes indicated in *Table 10*. Indicate the dominant type of secondary carbonates according to *Table 11* with the help of *Table 5*. Additionally, report the total exposed area

covered by secondary carbonates of any type. Report it in % related to the fine earth plus accumulations of secondary carbonates of any size and any cementation class. For this contest, the exposed area is considered to be equivalent to the volume.

Table 10. Carbonate contents in the soil matrix (IUSS Working Group WRB, 2022, Table 8.62)

Criterion	Content	% (by mass)	Code
No visible or audible effervescence	Non-calcareous	0	∅
Audible effervescence but not visible	Slightly calcareous	> 0 to 2	SL
Visible effervescence	Moderately calcareous	> 2 to 10	MO
Strong visible effervescence, bubbles form a low foam	Strongly calcareous	> 10 to 25	ST
Extremely strong reaction, thick foam forms quickly	Extremely calcareous	> 25	EX

Table 11. Types of secondary carbonates (IUSS Working Group WRB, 2022, Table 8.64)

Type	Code
Masses (including spheroidal aggregations like white eyes (byeloglaska); including masses filling the complete fine earth)	MA
Nodules and/or concretions	NC
Filaments (including continuous filaments like pseudomycelia)	FI
Coatings on soil aggregate surfaces or biopore walls	AS
Coatings on undersides of coarse fragments and of remnants of broken-up cemented layers (with or without coatings on other sides)	UR
No secondary carbonates	NO

2.7 Redoximorphic Features

Task on the scoresheet: Indicate the locations of the dominant oximorphic feature (redox concentration) and the dominant reductimorphic feature (redox depletion) for each mineral layer according to *Table 12* and *Table 13* with the help of *Figure 8*. Report the total abundance of oximorphic features and reductimorphic features, both for inner and outer locations, separately. Report them as percentage of the exposed area (related to the fine earth plus oximorphic features of any size and any cementation class). If redox features are absent, write ∅ in all relevant cells in the scoresheet.

Redoximorphic features (RMF) are soil morphological features caused by reduction processes or by reduction and subsequent oxidation processes. The reduction/oxidation of iron (Fe) and, to a lesser extent, manganese (Mn), minerals result in most RMFs. Iron is a major pigment that influences soil color. The loss, accrual, and valence/mineral state of Fe are major determinants of color patterns within or across soil layers. Microorganisms reduce iron or manganese when free oxygen is limited or excluded from a soil volume or layer by water saturation for extended time. Reduced iron (Fe^{2+}) and manganese (Mn^{2+}) are comparatively much more soluble and mobile than oxidized iron (Fe^{3+}) and manganese (Mn^{4+}) and move with water flow and due to redox gradients. Reduced Fe and Mn are oxidized and precipitate when water drains from soil (re-entry of free oxygen), or in parts where oxygen is still present. In soils with stagnant water, this is inside aggregates and in soils with ascending groundwater along soil pores, including root channels, or along roots. The re-oxidized Fe or Mn form concentrations like *masses*, *concretions or nodules* (see *Table 5*).

Oxidized Fe generally has a redder and more intense color than adjacent soil particles, while Mn often has a darker color than adjacent soil particles. Reductimorphic features (redox depletions) show the following colors:

- a hue of N, 10Y, GY, G, BG, B or PB or
- a hue of 2.5Y or 5Y and a chroma of ≤ 2.

In many layers, the redoximorphic features are present in addition to the dominant soil color (Section 2.5), but in some layers, the dominant soil color itself is the result of redox processes. This is expressed by the codes (*Table 12* and *Table 13*) and the percentages of the exposed area.

Table 12. Location of oximorphic features (IUSS Working Group WRB, 2022, Table 8.55, modified)

Location		Code
Inner parts	Inside soil aggregates: masses	OIM
	Inside soil aggregates: concretions and/or nodules	OIC
	Inside soil aggregates: combinations of masses, concretions and/or nodules	OIB
	Dominant color, including inner parts of soil aggregates	OID
Outer parts	On surfaces of soil aggregates	OOA
	Adjacent to surfaces of soil aggregates (hypocoats)	OOH
	On biopore walls	OOE
	Dominant color, including outer parts of soil aggregates and/or the biopore walls	OOD
Throughout	Throughout	ORT

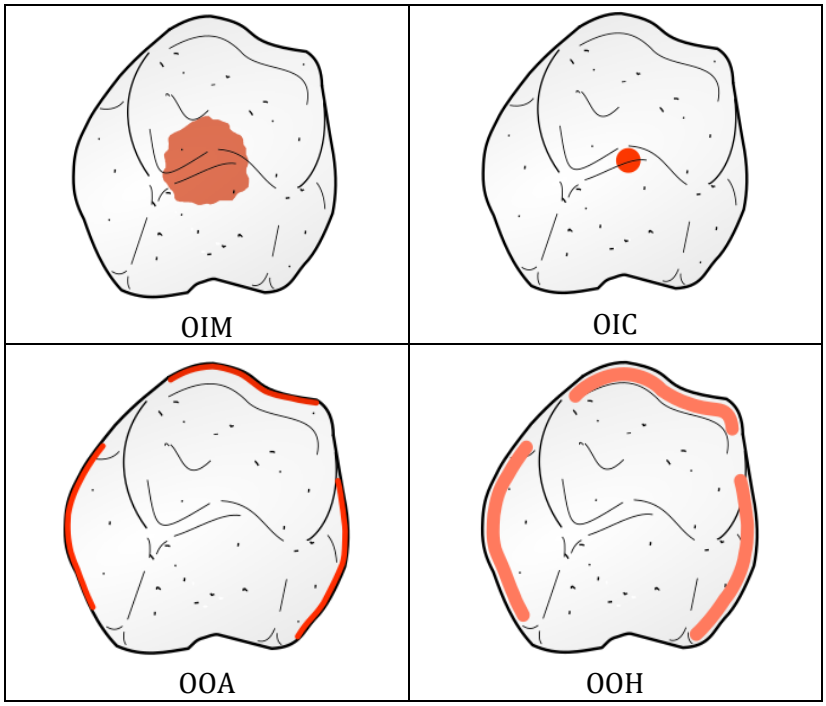

Figure 8. Location of some oximorphic features (IUSS Working Group WRB, 2002, Table 8.56, modified)

Table 13. Location of reductimorphic features (IUSS Working Group WRB, 2022, Table 8.56, modified)

Location		Code
Inner parts	Inside soil aggregates	RIA
	Dominant color, including inner parts soil aggregates	RID
Outer parts	Outer parts of soil aggregates	ROA
	Around biopores	ROE
	Dominant color, including outer parts of soil aggregates and/or the biopore walls	ROD
Throughout	Throughout	RRT

2.8 Aggregate Surface Features

Task on the scoresheet: Determine the dominant type of features at the surfaces of aggregates and along biopores, other than redoximorphic features, for each mineral layer using *Table 14*. For slickensides, the percentage of surfaces of soil aggregates covered is required. For clay coatings, the percentage of surfaces of soil aggregates and biopore walls covered is required.

Clay coatings (*Figure 9*) result from clay migration and show a shiny appearance due to illuviated clay minerals and a more intense color (usually a higher chroma) due to illuviated iron oxides. If sand grains are present, they are waxed over by clay particles. Stress features (*Figure 10*) do not differ in color from the interiors of the aggregates. They form when soil aggregates are pressed against each other due to swelling clay minerals. Striations form when sand grains are moved with strong pressure along the surfaces of aggregates sliding past each other. If striations are present, the stress features are called slickensides, otherwise they are called pressure faces.

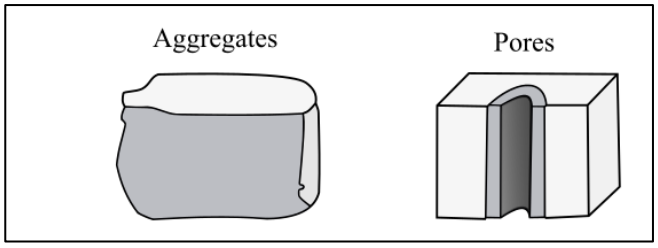

Figure 9. Clay coatings (Soil Survey Staff, 2024, 2-33; IUSS Working Group WRB, 2022, Figure 8.20)

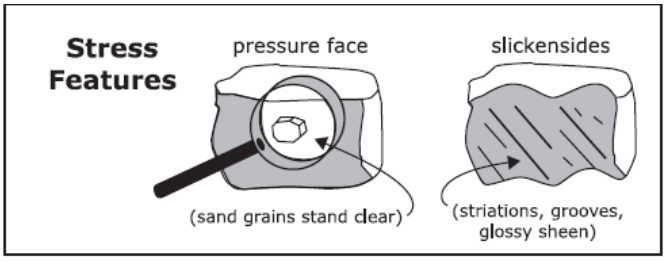

Figure 10. Stress features (Soil Survey Staff, 2024, 2-33)

Table 14. Aggregate surface features

Type and abundance	Code
Clay coatings, < 15% of surfaces of soil aggregates and biopore walls covered	CF
Clay coatings, ≥ 15% of surfaces of soil aggregates and biopore walls covered	CM
Slickensides, < 10% of surfaces of soil aggregates covered	SF
Slickensides, ≥ 10% of surfaces of soil aggregates covered	SM
Pressure faces, any abundance	PF
None	∅

2.9 Parent Materials

Task on the scoresheet: Determine the parent materials for each mineral layer according to *Table 15*. If the parent material is igneous, metamorphic or consolidated sedimentary rock, indicate only the *major class code*. If the parent material is unconsolidated sedimentary rock, indicate the *group code*.

Table 15. Types of parent materials (IUSS Working Group WRB, 2022, Table 8.91, modified)

Lithology	Major class code	Group code
Igneous rock	I	
Metamorphic rock	M	
Consolidated sedimentary rock	S	
Unconsolidated sedimentary rock: Weathered residuum	U	UR
Unconsolidated sedimentary rock: Fluvial	U	UF
Unconsolidated sedimentary rock: Lacustrine	U	UL
Unconsolidated sedimentary rock: Colluvial	U	UC
Unconsolidated sedimentary rock: Aeolian	U	UE
Unconsolidated sedimentary rock: Glacial	U	UG
Unconsolidated sedimentary rock: Anthropogenic/ Technogenic	U	UA
Unconsolidated sedimentary rock: Human-transported	U	UT

3 LAYER DESIGNATIONS

Teams and individual contestants must give the layer designations according to both Soil Taxonomy (ST, 13th edition, 2022) and World Reference Base for Soil Resources (WRB, 4th edition, 2022). The analytical data required for layer designation will be provided on the pitcard.

In both systems, the layer designations must be completed for both mineral and organic layers. The layer designation consists of four elements:

1. If a soil consists of more than one stratum (WRB: lithic discontinuity, ST: lithologic discontinuity), from the second stratum downwards, every layer designation starts with the **number of the stratum,** indicated with an Arabic numeral. The first stratum does not receive such a number.
2. The next is the **master symbol**, which is a capital letter indicating the major characteristics of the layer.
3. The master symbol may be followed by one or more lowercase letters, called **suffixes**.
4. If two or more layers have an identical combination of master symbol and suffixes, they have to be differentiated using Arabic **numerals**. Example: A-Bw1-Bw2-2Bw3-C.

Transitional layers are dominated by properties of one master layer but having subordinate properties of another. Two master symbols are used, such as AB, EB, BE or BC. The symbol of the material that dominates is given first.

Combination layers have distinct parts and recognizable properties of two kinds of master layers. The two master symbols are separated by a virgule (/), such as A/C, B/E, B/C or C/R if they occur side-by-side in the same layer and separated by an ampersand (&) if they occur alternating vertically such as lamellae. Contestants must describe only the dominant part.

3.1 World Reference Base for Soil Resources

Task on the scoresheet: Indicate the full layer designation. For the master symbol use *Table 16* and for the suffixes *Table 17*. A maximum of three suffixes may be used if applicable.

Specific rules for WRB:

- If organic layers occur and it is not obvious whether they are saturated by water or not, this information is given on the pitcard.
- The numerals differentiating identical combinations of master symbol and suffixes have to be used

even if interrupted by other layers. Example: A-E1-Bh1-E2-Bh2-C.

Table 16. Master symbols for layers in WRB (IUSS Working Group WRB, 2022, Table 10.1, modified)

Symbol	Short description
	Mineral layers
A	Mineral layer at the mineral soil surface or buried; contains organic matter that has at least partly been modified in situ; soil structure and/or structural elements created by agricultural practices in ≥ 50% (by volume, related to the fine earth); usually a darker color than underlying layers.
E	Mineral layer, at or near the mineral soil surface, characterized by a loss of one or more of the following: Fe, Al, clay minerals, organic matter; usually lighter in color (higher value and/or lower chroma) than the overlying A and underlying B.
B	Mineral layer that has (at least originally) formed below an A or E layer; rock structure, if present, in < 50% (by volume, related to the fine earth); one or more of the following processes of soil formation: • formation of soil aggregate structure • formation of clay minerals and/or oxides • accumulation by illuviation processes of one or more of the following: Fe, Al, clay minerals, organic matter, silica, carbonates, gypsum • removal of carbonates or gypsum.
C	Mineral layer, unconsolidated (can be cut with a spade when moist) or consolidated and more fractured than the R layer; may be partly chemically weathered, otherwise little affected by pedogenic processes.
R	Consolidated rock that cannot be cut with a spade; fractures, if present, occupy < 10% (by volume, related to the whole soil); not resulting from the cementation of a soil layer.
	Organic layers
O	Organic layer (≥ 20% (by mass) organic carbon), not forming part of a litter layer; O layers are not saturated by water for prolonged periods.
H	Organic layer (≥ 20% (by mass) organic carbon), not forming part of a litter layer; H layers are saturated by water for prolonged periods or have been drained.

Table 17. Suffixes for layers in WRB (IUSS Working Group WRB, 2022, Table 10.2, modified)

Suffix	Short description	Combination with
b	Buried layer; first, the layer has formed, and then, it was buried by mineral material	H, O, A, E, B
c	Concretions or nodules (only used if following another suffix that indicates the accumulated substance; by carbonates, gypsum, silica, Fe and Al oxides)	
g	Accumulation of Fe oxides predominantly inside soil aggregates or loss of Fe by lateral subsurface flow (as in stagnic properties)	A, B, C E
h	Significant amount of organic matter; in A layers at least partly modified in situ; in B layers predominantly by illuviation; in C layers forming part of the parent material	A, B, C
i	Slickensides and/or wedge-shaped aggregates	B
k	Accumulation of pedogenetic carbonates	H, O, A, E, B, C
m	Cementation by pedogenetic processes (only used if following another suffix that indicates the accumulated substance; by carbonates, gypsum, silica, soluble salts, Fe and Al oxides)	

l	Accumulation of Fe in reduced form by upward-moving capillary water with subsequent oxidation, predominantly at soil aggregate surfaces (as in gleyic properties)	H, A, B, C
p	Modification by cultivation (e.g. ploughing); mineral layers are designed A, even if they belonged to another layer before cultivation	H, O, A
r	Strong reduction (as in gleyic properties)	A, E, B, C
t	Illuvial accumulation of clay minerals (with or without associated oxides)	B, C
w	Formation of soil aggregate structure and/or oxides and/or clay minerals	B
α	Primary carbonates (in R layers related to the rock, in all others related to the fine earth) and no prominent accumulation of secondary carbonates	H, A, E, B, C, R
τ	Human-transported natural material	H, O, A, E, B, C,

3.2 Soil Taxonomy

Task on the scoresheet: Indicate the full layer designation. For the master symbol use *Table 18* and for the suffixes *Table 19.* A maximum of three suffixes may be used if applicable.

Specific rules for Soil Taxonomy:

- The carat symbol (^) is used as a prefix to identify human-transported material. (Designation of a lithologic discontinuity with the material beneath is an independent decision, depending on the source of the transported material).
- The prime (') is appended to a master symbol, when identically named layers exist but are not adjacent in the profile. Example: A-E-Bh-E'-B'h-C.

Table 18. Master symbols for layers in ST (Soil Survey Staff, 2024, 4-1 to 4-3, modified)

Symbol	Short description
	Mineral layers
A	Mineral soil material, formed at the surface or below an O layer, little remnant rock structure; one or more of the following: • accumulation of organic matter • properties resulting from cultivation • morphology resulting from surficial processes; usually a darker color than underlying layers.
E	Mineral layer, at or near the soil surface, characterized by a loss of one or more of the following: Fe, Al, clay minerals, organic matter; usually lighter in color (higher value and/or lower chroma) than the overlying A and underlying B.
B	Mineral layer that has (at least originally) formed below an A or E layer; little or no rock structure; one or more of the following processes of soil formation: • formation of soil aggregate structure • formation of clay minerals and/or oxides • accumulation by illuviation processes of one or more of the following: Fe, Al, clay minerals, organic matter, silica, carbonates, gypsum • removal of carbonates or gypsum.
C	Mineral soil material; soft or weakly to moderately cemented or highly cracked bedrock (can be cut with a spade when moist); may be partly chemically weathered, otherwise little affected by pedogenic processes.

R	Hard bedrock (continuous, coherent, at least strongly cemented) that cannot be cut with a spade; not resulting from the cementation of a soil layer.
Organic layers	
O	Organic layer (≥ 12% (by mass) organic carbon), not forming part of freshly fallen plant

Table 19. Suffixes for layers in ST (Soil Survey Staff, 2024, 4-3 to 4-6, modified)

Suffix	Short description	Used for
b	Buried pedogenetic layer	mineral layers
c	Concretions or nodules	mineral layers
d	Physical root-limitation, high bulk density (natural or human-induced)	mineral layers
g	Strong gleying (depleted matrix)	mineral layers
h	Illuvial and synthesized Al-humus complexes	mineral layers
k	Accumulation of secondary carbonates	mineral layers
kk	Accumulation of ≥ 50% pedogenic carbonates, soil fabric is plugged	mineral layers
m	Cementation by pedogenic processes	mineral layers
n	Pedogenic accumulation of exchangeable sodium	no restriction
p	Plowing or other human mixing disturbance	no restriction
r	Paralithic bedrock	no restriction
s	Illuvial and synthesized oxides of Fe, Mn, or Al	mineral layers
t	Illuvial accumulation of clay	mineral layers
w	Development of color or structure, absence of more advanced genesis	B layers
x	Fragic character (brittle nature of rupture)	mineral layers
y	Accumulation of secondary gypsum	mineral layers
z	Pedogenic accumulation of salts more soluble than gypsum	no restriction

4 SOIL PROFILE CHARACTERISTICS

For each of the four characteristics to be assessed, competitors are to place an 'X' in one box only.

4.1 Type of Restrictive Layer and Effective Soil Depth

Task on the scoresheet: Determine the type of restrictive layer and the effective soil depth class.

Restrictive layers include:

- Bedrock (ST: lithic or paralithic materials, WRB: continuous rock);
- Cemented layers with the layer suffix m (both ST and WRB)
- Layers with texture classes of SiC, C or SC that are structureless and massive.

Effective soil depth is defined as the depth from the soil surface to the upper boundary of a restrictive layer. Use the classes in *Table 20*. If the lower depth of judging is ≤ 120 cm, and there is no restrictive layer within or at the judging depth, the layer encountered at the bottom of the judged profile may be assumed to continue to > 120 cm and 'very deep' should be selected.

Table 20. Effective soil depth

Depth	Depth class	Code
≤ 20 cm	Very shallow	VS
> 20 to 40 cm	Shallow	S
> 40 to 80 cm	Moderately deep	MD
> 80 to 120 cm	Deep	D
> 120 cm	Very deep	VD

4.2 Hydraulic Conductivity

Task on the scoresheet: Determine the hydraulic conductivity class of the *mineral surface layer* and of the *layer with the lowest conductivity*.

Critical for agronomic soil functions and partitioning of rainfall, we will estimate the saturated hydraulic conductivity of the *mineral surface layer* and of the *layer with the lowest conductivity* within the depth specified on the pitcard.

Three general hydraulic conductivity classes are used:

High (H) – high hydraulic conductivity class is indicated with any of the following:

- Layers with texture classes of *sand* or *loamy sand*.
- *Sandy loam*, *sandy clay loam*, *silt loam* and *loam* texture classes that are especially 'loose' because of very high organic matter content (> 5% organic carbon).
- Layers containing > 60% of coarse fragments with insufficient fine earth to fill voids between fragments.

Moderate (M) – this includes those materials excluded from 'low' and 'high' classes.

Low (L) – low hydraulic conductivity class is indicated with any of the following:

- Layers with texture classes of *clay*, *silty clay* or *sandy clay* that have a structure grade of MO or WE or are structureless and massive.
- Layers with texture classes of *silty clay loam* and *clay loam* that have a structure grade of WE or are structureless and massive.
- Cemented layers with the layer suffix m (both ST and WRB).
- Bedrock layers (ST: lithic or paralithic materials, WRB: continuous rock) where the layer directly above contains reductimorphic features.

4.3 Available Water-Holding Capacity (AWC)

Task on the scoresheet: Determine the available water-holding capacity of the soil.

Critical to agronomic interpretations for crop growth, the available water-holding capacity (also called: available water capacity) is approximately the water held between field capacity (pF 1.8) and permanent wilting point (pF 4.2). The approximate amount of water stored in the soil is calculated for the top 150 cm of the soil profile. This soil thickness may or may not be the same as that designated for the purposes of profile descriptions. The total water is calculated by summing the amount of water held in each layer or portion of layer, if the layer extends beyond 150 cm. If a layer is unfavorable for roots (as defined under effective soil depth), this and all layers below must be excluded in calculating the available water. For available water calculations, the properties of the lowest layer designated for description can be assumed to extend to 150 cm, if no restrictive layer is present. If a restrictive layer is present between the lowest described layer and the 150 cm depth, the depth to the restrictive layer must be considered for available water estimations. Texture is an important factor influencing available water capacity. The relationship between texture classes and available water retained per centimeter of soil is given in *Table 21.* (Note: the actual AWC values for sand, loamy sand and sandy loam classes depend on the size of the sand grains, coarse sand has a smaller AWC than fine sand, but this is not accounted for in this contest. Also the AWC of organic layers is highly variable and decreases with advancing decomposition; the indicated value of 0.5 cm/cm is a rough mean value.)

Table 21. Relationship between texture classes and available water capacity

Texture classes	Available Water Capacity (cm water per cm soil)
sand, loamy sand	0.07
sandy loam	0.10
sandy clay loam, sandy clay, loam, clay loam, clay, silty clay	0.15
silt, silt loam, silty clay loam	0.20
layers with ≥ 12% organic carbon	0.50

Coarse fragments are considered to have negligible (assume zero) water retention. If a soil contains coarse fragments, the volume occupied by the coarse fragments must be estimated and the available water-holding capacity corrected accordingly.

For example, if a silt loam A layer is 25 cm thick and contains coarse fragments which occupy 10% of its volume, the available water-holding capacity of the layer would be
25 cm × 0.20 cm/cm × [(100-10)/100] = 4.50 cm
of water. Calculate the available water for each layer and sum all layers.

Four classes of available water-holding capacity will be used (*Table 22*):

Table 22. Available water-holding capacity

AWH Capacity	Class	Code
< 7.5 cm	Very low	VL
7.5 to < 15 cm	Low	L
15 to < 22.5 cm	Moderate	M
≥ 22.5 cm	High	H

4.4 Depth of Prolonged Water Saturation

Task on the scoresheet: Determine the depth of reductimorphic features comprising ≥ 10% of the exposed area.

Critical for understanding the effects of flooding, partitioning of water, drainage, habitat, water purification, and construction. Landscape position, slope gradient, infiltration rate, surface runoff, saturated hydraulic conductivity, porosity, and permeability are significant factors influencing the long-term average depth up to which the soil profile is water-saturated in average precipitation years. Saturation may be permanent or temporary. Prolonged periods of saturation cause the absence of oxygen, and microorganisms reduce Mn and Fe, producing reductimorphic features. Reductimorphic features that comprise ≥ 10% of the exposed area are considered indicators of prolonged water saturation in this handbook. Use *Table 23*.

Table 23. Shallowest depth where evidence of prolonged water saturation occurs

Criteria	Depth class	Code
Reductimorphic features comprising ≥ 10% of the exposed area occur in some part ≤ 25 cm	Very shallow	VS
Reductimorphic features comprising ≥ 10% of the exposed area occur in some part between > 25 and ≤ 50 cm but not shallower	Shallow	S
Reductimorphic features comprising ≥ 10% of the exposed area occur in some part between > 50 and ≤ 100 cm but not shallower	Moderately deep	MD
Reductimorphic features comprising ≥ 10% of the exposed area occur in some part between > 100 and ≤150 cm but not shallower	Deep	D
Reductimorphic features comprising ≥ 10% of the exposed area do not occur at ≤ 150 cm (see Notes below)	Very deep	VD

Notes: If reductimorphic features comprising ≥ 10% of the exposed area do not occur within the specified depth for judging and that depth is < 150 cm, then assume a class of very deep. Short duration free water in the soil pit may have been taken out by the organizers to allow participants to easily enter the pit to describe the profile. Therefore, the current depth of a water table does not necessarily indicate the depth where prolonged saturation occurs.

4.5 Surface Runoff

Task on the scoresheet: Determine the surface runoff class according to *Table 24* based on slope and the limiting (slowest) hydraulic conductivity class within 50 cm of soil surface (Section 4.2). Adjust to one slower class if there is < 10% bare ground (on average) between the slope stakes, unless the class is already *Very slow* or *Ponded*. Adjust to one more rapid class if the soil structure type in the mineral surface layer is structureless and massive or the surface is crusted in most of the area between the slope stakes, unless the rate is already *Ponded*. Soils with low amounts of bare soil exposed have slower runoff rates, and those with structureless massive or crusted surfaces have higher runoff. Soils with Low hydraulic conductivity class near the soil surface have higher runoff during prolonged heavy rainfall events once all the pores become filled.

Table 24. Surface runoff classes (Southeast Regional Collegiate Soil Contest Official Handbook, modified)

Slope	Limiting (slowest) hydraulic conductivity class within 50 cm of soil surface		
	High (H)	Moderate (M)	Low (L)
Depression	Ponded (P)	Ponded (P)	Ponded (P)
0 to 1% slope	Very slow (VS)	Very slow (VS)	Slow (S)
> 1 to 2% slope	Very slow (VS)	Slow (S)	Medium (M)
> 2 to 6% slope	Slow (S)	Medium (M)	Rapid (R)
> 6 to 12% slope	Medium (M)	Rapid (R)	Very rapid (VR)
> 12% slope	Rapid (R)	Very rapid (VR)	Very rapid (VR)

4.6 Potential Water Erosion

Task on the scoresheet: Determine the potential water erosion class according to *Table 25*. Take the surface runoff class (*Table **24***) and move across the table to the column with the texture of the mineral surface layer. The potential for losses by water erosion is influenced mainly by the texture of the mineral surface layer and the amount of surface runoff at a site, which already takes surface cover, slope, structure of the mineral surface layer, and near-surface conductivity classes into account.

Table 25. Classes of potential water erosion (Southeast Regional Collegiate Soil Contest Official Handbook, modified)

Surface runoff class	Mineral surface layer texture			
	S, LS and layers with ≥ 12 % C_{org}	SCL, SC	SL, CL, C, SiC	L, Si, SiL, SiCL
Ponded (P)	Very Low (VL)	Very Low (VL)	Very Low (VL)	Very Low (VL)
Very slow (VS)	Very Low (VL)	Very Low (VL)	Low (L)	Medium (M)
Slow (S)	Very Low (VL)	Low (L)	Medium (M)	Medium (M)
Medium (M)	Very Low (VL)	Low (L)	Medium (M)	High (H)
Rapid (R)	Low (L)	Medium (M)	High (H)	Very High (VH)
Very Rapid (VR)	Medium (M)	High (H)	Very High (VH)	Very High (VH)

5 INTERPRETATIONS

Remark to the host: Please select 4 out of the following suitability interpretations.

The following soil interpretation tables are used to allocate soils to a category of suitability for specific land uses.

For most rapid analysis of limitations:

1. Start in the right column of the tables.
2. Read down the column, checking the criteria.
3. If one factor is met in the right-hand column, place a mark in the Class 3 box on the scoresheet.
4. If none are met, check the middle column. If one factor is met in the middle column, place a mark in the Class 2 box on the scoresheet.
5. If none are met in either the right-hand or middle column, place a mark in the Class 1 box on the scoresheet.

5.1 Potato Production

Task on the scoresheet: Use *Table 26* to assess the suitability for potato production, with the most limiting factor of any of the soil and land characteristics to allocate a soil to a suitability class.

Table 26. Suitability factors for potato production

	Suitability		
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Texture class of thickest layer in upper 20 cm of soil	S, LS, SL or L	SiL, Si, CL, SiCL or SCL	SC, SiC or C
2. Effective soil depth class	VD or D	MD or S	VS
3. Hydraulic conductivity class of the layer with the lowest conductivity	H	M	L
4. pH value (water) of thickest layer in upper 20 cm of soil	> 5 to ≤ 5.5	> 5.5 to ≤ 7	≤ 5 or > 7
5. Slope gradient (%)	< 2	2 to 15	> 15

Note: Data on *pH* will be provided on pitcards at each pit.

5.2 Corn Production

Task on the scoresheet: Use *Table 27* to assess the suitability for corn production, with the most limiting factor of any of the soil and land characteristics to allocate a soil to a suitability class.

Table 27. Suitability factors for corn production

	Suitability		
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Electrical conductivity (dS/m, saturation extract) in thickest layer in upper 20 cm of soil	< 2	2 to 6	> 6
2. Depth of prolonged water saturation	VD or D	MD	S or VS
3. pH value (water) of thickest layer in upper 20 cm of soil	≥ 6 to ≤ 7	≥ 5.5 to < 6 or >7 to ≤ 8	< 5.5 or > 8
4. Available water-holding capacity class	H	M or L	VL
5. Slope gradient (%)	< 3	3 to 10	> 10

Note: Data on *electrical conductivity* and *pH* will be provided on pitcards at each pit.

5.3 Wheat Production

Task on the scoresheet: Use *Table 28* to assess the suitability for wheat production, with the most limiting factor of any of the soil and land characteristics to allocate a soil to a suitability class.

Table 28. Suitability factors for wheat production

	Suitability		
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Electrical conductivity (dS/m, saturation extract) in thickest layer in upper 20 cm of soil	< 4	4 to 8	> 8
2. Depth of prolonged water saturation	VD or D	MD or S	VS
3. pH value (water) of thickest layer in upper 20 cm of soil	≥ 6 to ≤ 7	≥ 5.5 to < 6 or >7 to ≤ 8	< 5.5 or > 8
4. Available water-holding capacity class	H or M	L	VL
5. Slope gradient (%)	< 6	6 to 15	> 15

Note: Data on *electrical conductivity* and *pH* will be provided on pitcards at each pit.

5.4 Paddy Rice Production

Task on the scoresheet: Use *Table 29* to assess the suitability for paddy rice production, with the most limiting factor of any of the soil and land characteristics to allocate a soil to a suitability class.

Table 29. Suitability factors for paddy rice production

	Suitability		
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Electrical conductivity (dS/m, saturation extract) of thickest layer in upper 20 cm of soil	< 1	1 to 4	> 4
2. pH value (water) of thickest layer in upper 20 cm of soil	> 5.5 to ≤ 7	> 7 to ≤ 8.4	< 5.5 or >8.4
3. Exchangeable sodium percentage of the surface layer	< 6	6 to 15	> 15
4. Texture class of thickest layer in upper 20 cm of soil	All others	SL	S or LS
5. Depth (cm) to the layer with the lowest hydraulic conductivity class	< 50	50 to 100	> 100

Note: Data on *electrical conductivity*, *pH* and *exchangeable sodium percentage* will be provided on pitcards at each pit.

5.5 Home Gardens

Task on the scoresheet: Use *Table 30* to assess the suitability for home gardens, with the most limiting factor of any of the soil and land characteristics to allocate a soil to a suitability class .

Table 30. Suitability factors for home gardens

	Suitability		
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Effective soil depth class	VD or D	MD	S or VS
2. Available water-holding capacity class	H	M or L	VL
3. Depth of prolonged water saturation	VD or D	MD or S	VS
4. pH value (water) in the surface layer (essential nutrient availability)	> 6 to ≤ 7	> 5 to ≤ 6 or > 7 to ≤ 7.4	> 7.4 or ≤ 5
5. Slope gradient (%)	< 5	5 to 10	> 10

Note: Data on *pH* will be provided on pitcards at each pit.

5.6 On-Site Septic Absorption Fields

Task on the scoresheet: Use *Table 31* to assess the suitability for on-site septic absorption fields, with the most limiting factor of any of the soil and land characteristics to allocate a soil to a suitability class.

Table 31. Suitability factors for on-site septic absorption fields

	Suitability		
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Depth (cm) to bedrock (ST: R or Cr, WRB: R)	> 150	100 to 150	< 100
2. Depth (cm) to the layer with *Low* hydraulic conductivity	> 150	≤ 50 or > 100 to ≤ 150	> 50 to ≤ 100
3. Depth of prolonged water saturation	VD	D	MD, S or VS
4. Flooding or ponding	None	None	Occurs
5. Slope gradient (%)	< 5	5 to 10	> 10

Note: Data on *flooding or ponding* will be provided on pitcards at each pit.

5.7 Buildings without Basements

Task on the scoresheet: Use *Table 32* to assess the suitability for buildings without basements, with the most limiting factor of any of the soil and land characteristics to allocate a soil to a suitability class.

Table 32. Suitability factors for buildings without basements

	Suitability		
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Shrink-swell potential in summer (surface cracks; slickensides anywhere in the upper 100 cm)	No surface cracks and no slickensides	Surface cracks ≤ 2 cm wide present but no slickensides	Surface cracks > 2 cm wide and/or slickensides present
2. Depth (cm) to bedrock (ST: R or Cr, WRB: R) or any cemented layer (ST and WRB: m)	> 150	100 to 150	< 100
3. Depth of prolonged water saturation	VD	D or MD	S or VS
4. Flooding or ponding	None	None	Occurs
5. Slope gradient (%)	< 8	8 to 15	> 15

Note: Data on *surface cracks* and *flooding or ponding* will be provided on pitcards at each pit.

5.8 Local Roads for Community Planning

Task on the scoresheet: Use *Table 33* to assess the suitability for building local roads, with the most limiting factor of any of the soil and land characteristics used to allocate a soil to a suitability class.

Table 33. Suitability factors for local roads for community planning

	Suitability		
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
1. Susceptibility to frost action in non-tropical regions (texture anywhere within the upper 100 cm)	S, LS or SL	All other textures	Si, SiL or SiCL
2. Shrink-swell potential in summer (surface cracks; slickensides anywhere in the upper 100 cm)	No surface cracks and no slickensides	Surface cracks ≤ 2 cm wide present but no slickensides	Surface cracks > 2 cm wide and/or slickensides present
3. Depth of prolonged water saturation	VD, D or MD	S	VS
4. Flooding or ponding	None	None	Occurs
5. Slope gradient (%)	< 5	5 to 20	> 20

Note: Data on *surface cracks* and *flooding or ponding* will be provided on pitcards at each pit.

6 DIAGNOSTICS AND SOIL CLASSIFICATION

The competitors must classify the soils according to both Soil Taxonomy (ST, 13th edition, 2022) and World Reference Base for Soil Resources (WRB, 4th edition, 2022). Additional data necessary for the classification will be provided on the pitcard at each pit. Please see the **Simplified WRB Diagnostics addendum** and **Keys to Soil Taxonomy addendum** for information specific to this contest.

Note to Contest Host:

For Soil Taxonomy, a Keys to Soil Taxonomy addendum will be supplied. For WRB, a Simplified WRB Diagnostics addendum will be supplied. The scoresheet should be adjusted based on the practice and contest soils to be seen, plus any other commonly found soils in the region, even if they are not shown.

For practice sites only, a national system can be given and explained. This would be of great interest to the students and coaches.

6.1 World Reference Base for Soil Resources (2022)

6.1.1 Diagnostic horizons/properties/materials

Task on the scoresheet: Use a cross (X) to select all the diagnostic horizons/properties/materials that apply to the profile within the specified judging depth. For detailed information on the horizons/properties/materials see Chapter 3 of the WRB.

6.1.2 Reference Soil Group

Task on the scoresheet: Use a cross (X) to select the Reference Soil Group (RSG). Use the key to the RSGs in Chapter 4 of the WRB.

6.1.3 Qualifiers

Task on the scoresheet: Use a cross (X) to select all the qualifiers that apply to the profile within the

specified judging depth. For detailed information on qualifiers see Chapter 5 of the WRB.

6.2 Soil Taxonomy (2022)

6.2.1 Epipedon

Task on the scoresheet: Use a cross (X) to select the epipedon that applies to the profile. For detailed information on the epipedon definitions see pages 7-19 of the Keys to Soil Taxonomy.

6.2.2 Subsurface horizons

Task on the scoresheet: Use a cross (X) to select all the subsurface horizons that apply to the profile within the specified judging depth. For detailed information on the subsurface horizon definitions see pages 19-31 of the Keys to Soil Taxonomy.

6.2.3 Diagnostic characteristics

Task on the scoresheet: Use a cross (X) to select all the diagnostic characteristics that apply to the profile within the specified judging depth. For detailed information on the diagnostic characteristic definitions see pages 31-55 of the Keys to Soil Taxonomy.

6.2.4 Order

Task on the scoresheet: Use a cross (X) to select the soil order. For the Keys to Soil Orders see pages 65-70 of the Keys to Soil Taxonomy.

6.2.5 Suborder

Task on the scoresheet**:** Use a cross (X) to select the soil suborder.

6.2.6 Great Group

Task on the scoresheet**:** Use a cross (X) to select the soil great group.

7 REFERENCES

IUSS Working Group WRB (2022): World Reference Base for Soil Resources. International soil classification system for naming soils and creating legends for soil maps. 4th edition. International Union of Soil Sciences (IUSS), Vienna, Austria.

Soil Survey Staff (2024): Field Book for describing and sampling soils. Version 4.0. USDA Natural Resources Conservation Service.

Soil Survey Staff (2022): Keys to Soil Taxonomy. 13th edition. USDA Natural Resources Conservation Service.

8 SCORING INFORMATION

<table>
<tr><td colspan="3">1. SITE DESCRIPTION</td></tr>
<tr><td>Land use
Landform
Slope position</td><td colspan="2">Only one answer for each is correct. For the correct answer, 1 point will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td>Slope gradient</td><td colspan="2">If the gradient is ≤ 5%, 1 point will be awarded if the answer is ± 1% correct compared to the value estimated by the organizers. If the gradient is > 5%, 1 point will be awarded if the answer is ± 2% correct. If the area is flat, only 0 is the correct answer.</td></tr>
<tr><td>Rock outcrops
Surface rock fragments</td><td colspan="2">1 point will be awarded if the answer is ± 10% correct compared to the values estimated by the organizers. If rock outcrops or surface rock fragments are absent, only 0 is the correct answer.</td></tr>
<tr><td>Human-made surface unnevenness</td><td colspan="2">Only one answer is correct. For the correct answer, 1 point will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td>Litter layer: area covered</td><td colspan="2">1 point will be awarded if the answer is ± 10% correct compared to the value estimated by the organizers. If a litter layer is absent, only 0 is the correct answer.</td></tr>
<tr><td>Litter layer: average thickness</td><td colspan="2">If the litter layer is ≤ 5 cm thick, 1 point will be awarded if the answer is ± 1 cm correct compared to the value estimated by the organizers. If the litter layer is > 5 cm thick, 1 point will be awarded if the answer is ± 2 cm correct. If a litter layer is absent, only 0 is the correct answer.</td></tr>
<tr><td colspan="3">2. SOIL DESCRIPTION</td></tr>
<tr><td>Layer lower depth</td><td colspan="2">The threshold of correct lower depth readings depends on the distinctness of the boundary.
Abrupt: ± 1cm
Clear: ±3 cm
Gradual/Diffuse: ±8 cm.
For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td>Layer boundary distinctness</td><td colspan="2">Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td>Layer boundary shape (topography)</td><td colspan="2">Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td>Texture class</td><td colspan="2">Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td rowspan="4">Texture clay %</td><td colspan="2">A scaled range for correct answers compared to values obtained from laboratory data will be used according to:</td></tr>
<tr><td>Measured clay content</td><td>Range for grading</td></tr>
<tr><td>< 20 %</td><td>± 4 %</td></tr>
<tr><td>20 to 40 %</td><td>± 6 %</td></tr>
<tr><td>> 40 %</td><td>± 8 %</td></tr>
<tr><td rowspan="4">Texture sand %</td><td colspan="2">A scaled range for correct answers compared to values obtained from laboratory data will be used according to:</td></tr>
<tr><td>Measured sand content</td><td>Range for grading</td></tr>
<tr><td>< 20 %</td><td>± 6 %</td></tr>
<tr><td>20 to 40 %</td><td>± 8 %</td></tr>
<tr><td>> 40 %</td><td>± 10 %</td></tr>
</table>

Rock fragments and artefacts: %	A scaled range for correct answers compared to the value estimated by the organizers will be used. 2 points will be awarded if the answer is ± 5% correct, 1 point if the answer is ± 10% correct. If rock fragments are absent, only 0 is the correct answer.
Rock fragments and artefacts: weighted average %	The points are awarded if the calculations based on the rock fragment contents and the layer thicknesses estimated by the contestants are correct. A scaled range will be used. 2 points will be awarded if the answer is ± 5% correct, 1 point if the answer is ± 10% correct. If rock fragments are absent, only 0 is the correct answer.
Structure type	Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.
Structure grade	Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.
Soil color hue	Only one answer is correct. For the correct answer, 1 point will be awarded. For an incorrect answer, 0 points will be awarded.
Soil color value	For the correct answer, 2 points will be awarded. If the answer is lower or higher than the correct one by 1 value category, 1 point will be awarded. If the answer is lower or higher than the correct one by 2 value categories, 0 points will be awarded.
Soil color chroma	For the correct answer, 2 points will be awarded. If the answer is lower or higher than the correct one by 1 chroma category, 1 point will be awarded. If the answer is lower or higher than the correct one by 2 chroma categories, 0 points will be awarded.
Carbonate content	Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.
Secondary carbonates: type	Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.
Secondary carbonates: %	1 point will be awarded if the answer is ± 5% correct, compared to the value estimated by the organizers. If secondary carbonates are absent, only 0 is the correct answer.
Redox features: location of oximorphic features	Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.
Redox features: location of reductimorphic features	Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.
Redox features: oximorphic inner: %	1 point will be awarded if the answer is ± 5% correct, compared to the value estimated by the organizers. If oximorphic features are absent, only 0 is the correct answer.
Redox features: oximorphic outer: %	1 point will be awarded if the answer is ± 5% correct, compared to the value estimated by the organizers. If oximorphic features are absent, only 0 is the correct answer.
Redox features: reductimorphic inner: %	1 point will be awarded if the answer is ± 5% correct, compared to the value estimated by the organizers. If reductimorphic features are absent, only 0 is the correct answer.
Redox features: reductimorphic outer: %	1 point will be awarded if the answer is ± 5% correct, compared to the value estimated by the organizers. If reductimorphic features are absent, only 0 is the correct answer.
Aggregate surface features: type	Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.
Aggregate surface features: %	1 point will be awarded if the answer is ± 5% correct, compared to the value estimated by the organizers.

<table>
<tr><td>Parent material</td><td>Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td colspan="2">3. LAYER DESIGNATIONS</td></tr>
<tr><td>Stratum</td><td>Only one answer is correct. For the correct answer, 1 point will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td>Master symbol</td><td>The correct answer is either one symbol or a combination of two symbols or a combination of two symbols separated by a virgule. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded. If for a transitional layer only one master symbol is reported and this one belongs to the correct ones, 1 point will be awarded.</td></tr>
<tr><td>Suffix(es)</td><td>Multiple suffixes might be correct. The maximum number of indicated suffixes is three. If all of the required suffixes are indicated, 3 points will be awarded. The following examples illustrate the case when incorrect answer is given or suffix/suffixes is/are missing.
<table>
<tr><th>Correct answer</th><th>Your answer</th><th>Calculation</th><th>Point(s)</th></tr>
<tr><td>Bk</td><td>Bk</td><td>3-0</td><td>3</td></tr>
<tr><td>Bk</td><td>Bl</td><td>3-3</td><td>0</td></tr>
<tr><td>Bhs</td><td>Bs</td><td>3-1</td><td>2</td></tr>
<tr><td>Btnh</td><td>Bt</td><td>3-2</td><td>1</td></tr>
<tr><td>Btnh</td><td>Btsg</td><td>3-2</td><td>1</td></tr>
</table></td></tr>
<tr><td>Numeral</td><td>Only one answer is correct. For the correct answer, 2 points will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td colspan="2">4. SOIL PROFILE CHARACTERISTICS</td></tr>
<tr><td>Effective soil depth</td><td rowspan="8">Only one answer is correct. For the correct answer, 3 points will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td>Type of restrictive layer</td></tr>
<tr><td>Hydraulic conductivity: Surface layer</td></tr>
<tr><td>Hydraulic conductivity: Layer with lowest cond.</td></tr>
<tr><td>AWC</td></tr>
<tr><td>Depth of prolonged water saturation</td></tr>
<tr><td>Surface runoff</td></tr>
<tr><td>Potential water erosion</td></tr>
<tr><td colspan="2">5. INTERPRETATIONS</td></tr>
<tr><td>All</td><td>For every interpretation, only one answer is correct. For the correct answer, 3 points will be awarded. For an incorrect answer, 0 points will be awarded.</td></tr>
<tr><td colspan="2">6.1. DIAGNOSTICS AND SOIL CLASSIFICATION - WRB</td></tr>
<tr><td>Diagnostic horizons</td><td>Multiple answers might be correct. If correct horizons are marked, 10 points will be awarded for each one. If incorrect horizons are marked, -10 points will be awarded. The overall score cannot be lower than 0.</td></tr>
<tr><td>Diagnostic properties</td><td>Multiple answers might be correct. If correct properties are marked, 5 points will be awarded for each one. If incorrect properties are marked, -5 points will be awarded. The overall score cannot be lower than 0.</td></tr>
<tr><td>Diagnostic materials</td><td>Multiple answers might be correct. If correct materials are marked, 5 points will be awarded for each one. If incorrect materials are marked, -5 points will be awarded. The overall score cannot be lower than 0.</td></tr>
</table>

RSG	Only one answer is correct. For the correct RSG, 15 points will be awarded. For an incorrect RSG, 0 points will be awarded.
Qualifiers	Multiple answers might be correct. If correct qualifiers are marked, 5 points will be awarded for each one. If incorrect qualifiers are marked, -5 points will be awarded. The overall score cannot be lower than 0.
6.2 DIAGNOSTICS AND SOIL CLASSIFICATION - SOIL TAXONOMY	
Epipedon	Only one answer is correct. For the correct epipedon, 10 points will be awarded. For an incorrect epipedon, 0 points will be awarded.
Subsurface horizons	Multiple answers might be correct. If correct horizons are marked, 5 points will be awarded for each one. If incorrect horizons are marked, -5 points will be awarded. The overall score cannot be lower than 0.
Diagnostic characteristics	Multiple answers might be correct. If correct characteristics are marked, 5 points will be awarded for each one. If incorrect characteristics are marked, -5 points will be awarded. The overall score cannot be lower than 0.
Order	Only one answer is correct. For the correct Order, 10 points will be awarded. For an incorrect Order, 0 points will be awarded.
Suborder	Only one answer is correct. For the correct Suborder, 5 points will be awarded. For an incorrect Suborder, 0 points will be awarded.
Great Group	Only one answer is correct. For the correct Great Group, 5 points will be awarded. For an incorrect Great Group, 0 points will be awarded.

9 SCORESHEET (BLANK)

Your logo goes here

SCORESHEET

Profile ID.............. Contestant ID.............. Describe.......horizons to a depth of..............cm Nail at.......cm at the bottom of horizon..... (Additional nail at.......cm at the bottom of horizon.....)

1. SITE DESCRIPTION

SCORE:

Land Use	Landform	Slope		Rock outcrops	Surface rock fragments	Surface unevenness	Litter layer	
Type (1)	*Type (1)*	*Position (1)*	*Gradient % (1)*	*% (1)*	*% (1)*	*Type (1)*	*Area covered % (1)*	*Average thickn. (cm) (1)*

2. PROFILE DESCRIPTION

SCORE:

Layer boundaries				Texture			Rock fragments		Structure		Color			Carbonates			Redoximorphic features						Aggregate surfaces		Par. mat
No.	*Lower Depth (cm) (2)*	*Distinctness (2)*	*Shape (2)*	*Class (2)*	*Clay % (2)*	*Sand % (2)*	*% (2)*	*Weight. Aver. % (2)*	*Type (2)*	*Grade (2)*	*Hue (1)*	*Value (2)*	*Chroma (2)*	*Content (2)*	*Sec. carb. Type (2)*	*Sec. carb. % (1)*	*Oxim. Loc. (2)*	*Reductim. Loc. (2)*	*Oxim. inner % (1)*	*Oxim. outer % (1)*	*Reductim. inner % (1)*	*Reductim. outer % (1)*	*Type (2)*	*% (1)*	*Type (2)*
1																									
2																									
3																									
4																									
5																									
6																									

3.1 LAYER DESIGNATIONS (WRB)

No.	Stratum (1)	Master (2)	Suffix(es) (3)	Numeral (1)
1				
2				
3				
4				
5				
6				

3.2 LAYER DESIGNATNIONS (ST)

No.	Stratum (1)	Master (2)	Suffix(es) (3)	Numeral (1)
1				
2				
3				
4				
5				
6				

4. SOIL CHARACTERISTICS

SCORE:

Type of restrictive layer (3)	Effective soil depth (3)	Hydraulic conductivity Surface layer (3)	Hydraulic conductivity Layer with lowest cond. (3)	AWC (3)	Depth of prolonged water saturation (3)	Surface runoff (3)	Potential water erosion (3)
Bedrock	VS	High	High	VL	VS	P	VL
Cemented	S	Moderate	Moderate	L	S	VS	L
Massive clay	MD	Low	Low	M	MD	S	M
None	D			H	D	M	H
	VD				VD	R	VH
						VR	

5. EVALUATION **SCORE:**

Suitability class				
Optimal				
Suitable				
Unsuitable				

SCORE SUMMARY

Name examiner		
1.		
2.		
3.1		
3.2		
4.		
5.		
6.1		
6.2		
Total		

Final score.....

6.1 CLASSIFICATION (WRB) **SCORE:**

Diagnostic horizons (10)	Diagnostic properties (5)	Diagnostic materials (5)	Reference Soil Group (15)	Qualifiers (5)

6.2 CLASSIFICATION (ST) **SCORE:**

Epipedon (10)	Subsurface horizons (5)	Diagnostic characteristics (5)	Order (10)	Suborder (5)	Great Group (5)	Subgroup (5)
Mollic						
Ochric						
Umbric						
None						

10 CHARTS FOR ESTIMATING PERCENTAGES

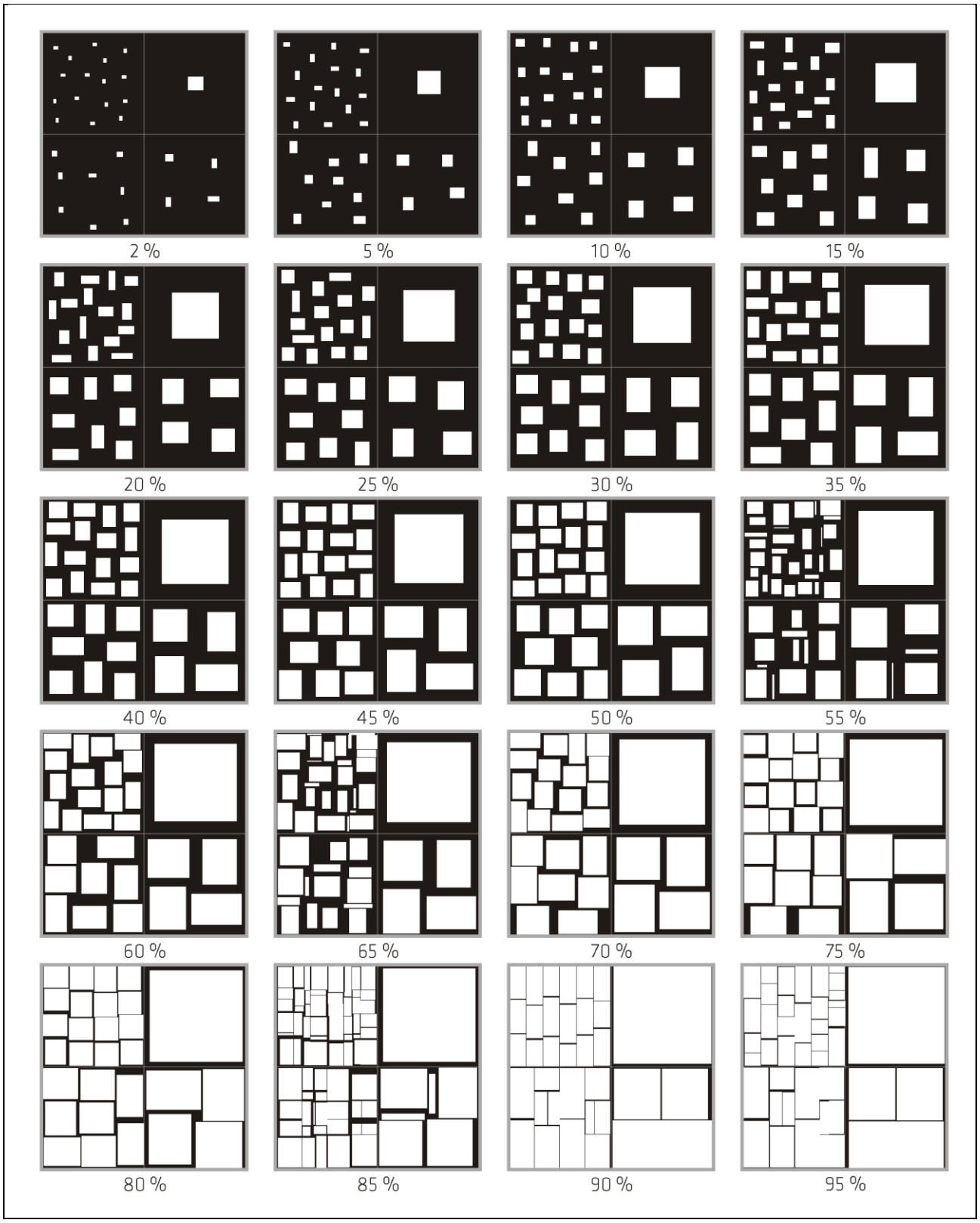

Figure 11. Charts for estimating percentages (IUSS Working Group WRB, Figure 8.12, modified)