20th World Congress of Soil Science

Soils Embrace Life and Universe

June 2014, Jeju KOREA

Official Handbook

Inaugural International Soil Judging Contest

June 5–7, 2014

Jeju, Korea

IUSS

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Overview of the Contest

The inaugural International Soil Judging Contest (ISJC) will be held from Thursday June 5^{th} to Saturday June 7^{th} 2014, inclusive, on Jeju island, Korea. The ISJC will immediately precede the 20^{th} World Congress of Soil Science, and is open to teams of soil science students from IUSS member nations.

There are several aims of this contest; to encourage the wider adoption of the discipline of soil judging around the world, to give motivated students an opportunity to assess soil 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.

The ISJC will consist of two days of practice soil description and interpretation, followed by a contest day. During the practice days, local soil scientists will give short information sessions on different aspects of the soil, geology and geomorphology of Jeju. Each team will have an accompanying academic coach, who will assist students in the field during the practice days, but not during the contest day. The contest day will consist of two soil pits to be team judged and two soil pits to be individually judged.

Conduct of the Contest

1. Contest sites

At each site, a pit will be excavated exposing a profile. A typical section will be selected in each pit and clearly designated as the *control section* by the contest officials. The control section will be used for measurement of horizon depths and boundaries; it will constitute the officially scored profile and must remain undisturbed and unblocked by competitors. All measurements should be made within the designated area. A measuring tape will be placed in the control section at all contest pits and will be maintained by official pit monitors. The competitors will describe up to six horizons within a given depth. A card at each site will give the profile depth to be considered, the number of horizons to be described, the depth of a nail placed within the third horizon, and chemical or physical data that may be required for classification. Changes to the group/individual contest schedule and the "time in and out" of pits may be made prior to the coaches meeting depending on the number of participants and pit and weather conditions.

Individual Contest

Sixty minutes will be allowed for evaluating each site for individual judging. Competitors will be assigned by team number to one of two groups at each site. One group will follow this schedule: 10 minutes in the pit, 10 minutes out, 10 minutes in, 10 minutes out, and 20 minutes free-for-all. The other group will follow the opposite in-and-out schedule. At alternating sites the competitors will switch the in-and-out schedule. Competitors may obtain a sample from the surface horizon while out of the pit, provided they do not enter the pit or disturb those already in the pit. Individual competitors will be assigned a number that will be used to identify their scorecard and the rotation schedule. The procedures for student rotation and time in and out of the pit may be altered prior to the contest to meet unanticipated difficulties at the site.

Team Contest

Fifty to 60 minutes will be allowed for teams to evaluate each of the two sites. The time will be divided into 10-minute segments similar to the individual contest. Teams will be randomly assigned a team number at registration. All competitors in a team may participate in the team contest. The starting time(s) of the team contest will be announced at the coaches' meeting.

2. Equipment and reference materials

The following equipment will be supplied to each team for the duration of the contest;

Clipboard	Water bottle
Abney level or clinometer	Acid (10% HCl) dropper bottle
Non-programmable calculator	Hand towel
Container for soil samples	Soil knife/digging tool
Pencils (No. 2 suggested)	Hand lens

Teams and individual competitors are requested to bring their own Munsell Soil Color Chart books to the contest, as only a limited number can be supplied by the organizers.

Teams and individual competitors may bring their own equipment from the list above if they wish, with the exception of acid bottles which should not be brought in by competitors. Any competitor found in possession of equipment other than those listed above will be disqualified.

The following reference materials will be permitted during the contest;

This Handbook
Key to relevant soil Orders and Suborders of *Soil Taxonomy*
Key to Reference Soil Groups and Qualifiers of the *WRB*

Any competitor found in possession of resources other than those listed above will be disqualified.

3. Scoring

General

All competitors will use the standard scoresheet depicted in Appendix 1. It will consist of five sections. All boxes on the scoresheet will be scored for the number of horizons required. If no entry is needed, then the contestant must enter a dash (---). Boxes left blank will be marked wrong. A list of acceptable abbreviations can be found in Appendix 2; each competitor will receive a copy for use during the contest. Illegible entries or any abbreviations other than those listed in Appendix 2 will be marked wrong. Input from coaches on scoring decisions is welcome, but decisions of the contest officials will be final. If a pedon has more than one parent material or diagnostic subsurface horizon/qualifier, 5 points will be awarded for each correct answer. In these sections of the scoresheet, negative credit (minus 5 points for each extra answer, with a minimum score of zero for any section) will be used to discourage guessing. More than one entry in other areas of the scoresheet that require one answer will be considered incorrect, and will result in no credit for that item. For example, if ash and residuum are the correct parent materials, then 5 points will be awarded for each. If a competitor checks ash (+5) and colluvium (0), the score will be 5; and if the competitor checks ash (+5), residuum (+5), and colluvium (-5 extra answer) the score would be five because of the excessive answer. Omissions will not be given any points. In all other situations, points will be awarded as indicated on the scoresheet.

Score tabulation

The overall team score will be the sum of the top three individual scores achieved in the individual contest plus the scores from the team contest. In this manner, all four team members may contribute to the overall team score. An example of the scoring for the individual portion of the contest is shown below:

INDIVIDUAL	**SITE 1**	**SITE 2**	**TOTAL**	
A	232	241	473	Scores used for individual ranking
B	261	262	523	
C	208*	277	485	
D	275	234*	509	
Total	**768**	**780**	**1548 = Team score**	

* Lowest score is not used to determine team score.

The team score from individual portion of the contest is then added to the scores for the two team contest sites to determine the overall team score.

Awards

Awards will be made to the five competitors with the highest aggregate point score for the two individual judging contest pits, the three teams with the highest aggregate score for the two team judging contest pits, and to the three teams with the highest overall team scores.

The Scoresheet

PART I: SOIL MORPHOLOGY

1. Horizonation

The full horizon designation will include a numeric prefix, a capitalised alphabetic master designation, a lower case alphabetic subordinate designation, and, if applicable, a numerical subdivision.

Master – **Prefix**

In mineral soils, Arabic numerals are used as prefixes to indicate that a soil has not formed entirely in one kind of material, which is referred to as a *lithologic discontinuity*. Wherever needed, the numerals precede the master or transitional horizon designation. A discontinuity is recognized by a significant change in particle-size distribution or mineral suite that typically indicates the horizons formed in different parent materials. Stratification common to soils formed in alluvium is not designated as a discontinuity, unless particle-size distribution differs markedly from layer to layer (is strongly contrasting), even if genetic horizons have formed in the contrasting layers.

When a discontinuity is identified, prefix numbering starts in the material underlying the surficial deposit and is designated by adding a prefix of '2' to all horizons and layers that formed in the material underlying the discontinuity (note the '1' is implied and not actually added to the surface deposit). There is no minimum number of horizons and layers needed in materials that underlie the surficial deposit. If another discontinuity is found below material with prefix '2', the horizons and layers formed in the third material are designated by the prefix '3'. For example, Ap, E, Bt1, 2Bt2, 2Bt3, 3BC. The number suffixes designating subdivisions of the Bt horizon continue in consecutive order across the discontinuity. A discontinuity prefix is not used to distinguish material of buried (b) horizons that formed in material similar to that of the overlying deposit (no discontinuity). For example, A, Bw, C, Ab, Bwb1, Bwb2, C.

If there is no discontinuity present, place a dash (–) in the prefix box for each horizon.

Master – **Letter**

The **Letter** column is to indicate the appropriate master horizon designations (i.e., A, E, B, C, or R) and combinations of these letters (e.g., AB, E/B, etc.). O horizons or layers will not be described in this contest. All depth measurements should be taken from the nail in the third horizon. R horizons should only be identified in the **Letter** column if within the judging depth. However, R horizons will not otherwise be described, so all other columns in that row should be marked with a dash (–). This is also true for Cr horizons, except that the 'C' is in the **Letter** column and the 'r' is in the **Sub** column. All remaining columns for Cr horizons should be dashed.

Horizon designations to be used are:

A horizon **(A)**: surface or near-surface mineral horizon with some organic accumulation, usually a darker colour than underlying horizons and/or smaller clay content than underlying horizons

E horizon **(E)**: a near-surface mineral horizon characterised by a loss of clay, iron, aluminium, or some combination of these; usually lighter in color (higher value and/or lower chroma) than the overlying A and underlying B

B horizon **(B)**: a mineral horizon characterised by one or more of the following: a concentration of clay, iron, aluminium, organic material or several of these; a structure and/or consistence unlike the horizons above and below; stronger colours (higher chroma and/or redder hue) than the horizons above and below

C horizon **(C)**: consolidated or unconsolidated material, usually partly weathered, little affected by pedogenic processes

R horizon **(R)**: hard bedrock that cannot be cut with a spade.

Transition horizons (**AE, AB, AC, EA, EB, BA, BE, BC, CA, CB):** transitional horizons that have characteristics of both the overlying and underlying horizon, but is more like the horizon that is designated first.

Transition horizons (**A/B, A/E, A/C, E/A, E/B, B/A, B/E, B/C, C/A, C/B)**: horizon comprised of individual (distinct) components of each master horizon in which the first designated horizon component is dominant and surrounds the material of the second horizon.

Sub – Subordinate distinctions

Enter lower case letters to designate specific kinds of master horizons if needed. If none, enter a dash. Students should be familiar with applications of the following subordinate distinctions: **b** (buried genetic horizon), **d** (physical root restriction), **g** (strong gleying), **k** (accumulation of secondary carbonates), **p** (tillage or other disturbance), **r** (weathered or soft bedrock), **t** (accumulation of silicate clay), and **w** (development of color or structure). If used in combination, the suffixes must be written in the proper order. Some type of subordinate distinction always follows the B master horizon. Subordinate distinctions on transitional horizons will not be used when the horizon is transitioning from or to a B horizon.

In this region many "wet" soils will contain a few nodules and concretions; however, based on the amount of these materials the suffix **c** will not be used. The suffix **b** will be used only when a buried solum, including an A horizon, is clearly expressed.

No. – Numerical subdivisions

Enter Arabic numerals whenever a horizon identified by the same combination of letters needs to be subdivided. If a subordinate distinction or a numerical subdivision is not used with a given master horizon, enter a dash (–) in the appropriate space on the scorecard.

2. Boundary

Lower depth

Up to six horizons will be described within a specified depth noted on the pit sign. Determine the depth (in cm) from the mineral soil surface to the lower boundary of each horizon except the last horizon. For a subsoil horizon that occurs between 23 and 37 cm below the soil surface, enter '37'. The last horizon boundary should be the specified judging depth with a '+' added, unless the specified depth is at a very evident horizon boundary, such as a lithic or paralithic contact, when the '+' is not used.

If a lithic or paralithic contact occurs at or above the specified depth on the pit sign, the contact should be considered in evaluating the available water holding capacity, effective soil depth, and limiting hydraulic conductivity. Otherwise, the last horizon should be assumed to extend to 150 cm for making all relevant evaluations. If a lithic or paralithic contact occurs within the specified depth, the contact should be considered as one of the horizons to be included in the description, and the appropriate horizon nomenclature should be applied (i.e., Cr or R). However, morphological features need not be provided and dashes should be used on the scoresheet. If the competitor gives morphological information, it will be ignored by the graders and will not count against the total score. If in doubt concerning the nature of the horizon, the competitor is advised to provide all of the information for that horizon.

Horizons less than 8 cm thick (no matter how contrasting) should not be described in this contest. If a horizon is less than 8 cm thick occurs, combine it for depth measurement purposes with the adjoining horizon that is more similar (e.g., a thin, discontinuous E horizon might be combined with an adjoining BE). When two horizons are combined to give a total thickness of 8 cm or more, always describe the properties of the thicker horizon.

Depth measurements should be taken from the nail. The allowed range of lower depths considered correct will depend on the distinctness of the boundary;

Distinctness of boundary	Range for grading
Abrupt (<2 cm)	± 1 cm
Clear (2–5 cm)	± 3 cm
Gradual (5–15 cm)	± 8 cm
Diffuse (>15 cm)	± 15 cm

Distinctness

The distinctness of each horizon's lower boundary is to be evaluated with reference to the table below. The distinctness of the lower boundary of the last horizon is not to be determined unless it is at a lithic or paralithic contact. If the lower depth to be judged is at a lithic or paralithic contact, indicate the distinctness; if there is no lithic or paralithic contact, place a dash (–) in the box. The topography or shape of the boundaries will not be recorded.

Vertical height of horizon transition	Distinctness	Value to be entered on scoresheet
<2 cm	Abrupt	A
2–5 cm	Clear	C
5–15 cm	Gradual	G
>15 cm	Diffuse	D

3. Texture

Clay (%)

For each horizon, an estimate of the clay content as a weight percentage of the soil fines (<2 mm) should be placed in the space provided. A scaled range for correct answers compared to values obtained from laboratory data, will be used according to:

Actual clay content (%)	Range for grading
<20	± 2
20–40	± 3
>40	± 4

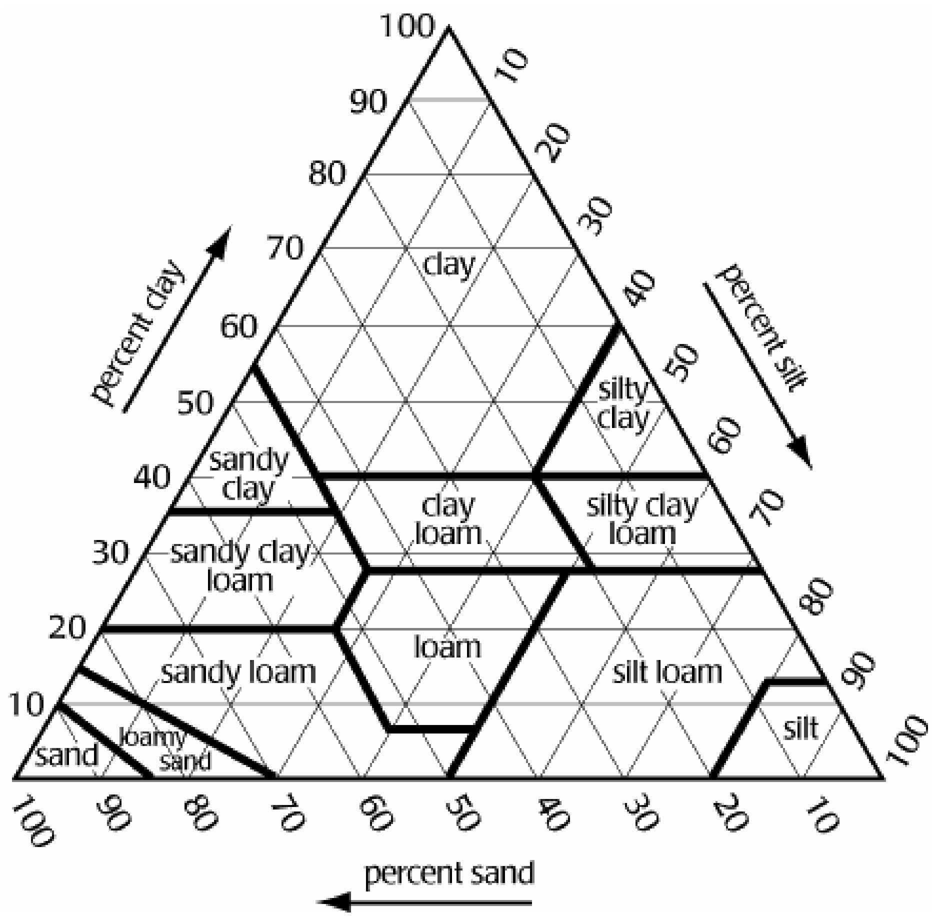
Note: in addition to the practice pit soils, examples of other Jeju soils with different clay contents will be supplied to the teams during the practice days to allow 'local calibration'.

Class

Determinations of texture class will follow the USDA Textural Classification, which includes twelve main classes. Acceptable abbreviations for texture class are the following:

Texture class	Abbreviation
Sand	S
Loamy sand	LS
Sandy loam	SL
Loam	L
Silt loam	SIL
Silt	SI

Texture class	Abbreviation
Sandy clay loam	SCL
Clay loam	CL
Silty clay loam	SICL
Sandy clay	SC
Silty clay	SIC
Clay	C



Sand fraction modifiers

Although the sand contents of soils in Jeju are generally very low, and the identification of the main sand fraction size usually unnecessary, the following sand fraction modifiers will nevertheless be included in this contest.

For the texture classes of Sand, Loamy sand and Sandy loam, the dominant sand fraction is assumed to be <u>medium sand</u>. If the dominant sand fraction is not medium sand, a modified abbreviation is required as follows;

Texture class	Dominant sand fraction	Abbreviation
Sand	very fine sand	VFS
	fine sand	FS
	coarse sand	COS
Loamy sand	very fine sand	VFLS
	fine sand	FLS
	coarse sand	COLS
Sandy loam	very fine sand	VFSL
	fine sand	FSL
	coarse sand	COSL

Coarse fragment modifers

Coarse fragments are also relatively rare in Jeju soils, but modification of the textural class will be required if the horizon contains more than 15% by volume coarse fragments (>2 mm), which includes carbonate and ironstone nodules. Sieves will be allowed during the contest for this assessment, where necessary. The following terms will be used to describe coarse fragments:

Gravelly – fragments 2-75 mm diameter of any lithology and shape.

Cobbly – fragments of any shape and lithology that are >75 mm diameter by their long axis.

If gravels and cobbles occur in the same horizon, the dominant fraction should be described.
Coarse fragment modifiers should be added to texture class abbreviations as follows:

Coarse fragment (volume %)	Modifier	Addition to texture class abbreviation
<15	None required	–
15–34	Gravelly	GR
	Cobbly	CB
35–60	Very gravelly	VGR
	Very cobbly	VCB
>60	Extremely gravelly	EGR
	Extremely cobbly	ECB

For example, if the horizon has a texture of clay loam with 40% by volume gravel-size fragments, the correct texture designation should be VGRCL (very gravelly clay loam).

4. Color

Munsell soil color charts must be used to determine the ***moist*** color of each horizon described. Colors must be designated by **Hue**, **Value** and **Chroma**. Color names such as 'pale brown' will not be accepted as correct answers. Partial or full credit may be given for colors close to the official evaluation, either in hue, value or chroma. In the case of surface horizons, color is to be determined on rubbed samples. The color recorded for soil material from any other horizon, including mottled horizon, should be the dominant, unrubbed color of the ped interior, not a ped surface or cutan.

5. Structure

Structure is the naturally occurring arrangement of soil particles into aggregates that results from pedogenic processes. In this contest, structure grade and type will be assessed. Grade describes the distinctness of individual ped units, while type describes the dominant shape of the peds.

Grade

Record the dominant structure grade for each horizon using one of the following values;

Structure grade	Description	Value to be used in scoresheet
Structureless	No peds observable; massive or single grained shape	0
Weak	Peds indistinct and barely observable; up to one-third of the soil consists of peds	1
Moderate	Peds well-formed and evident; more than one-third of the soil consists of peds	2
Strong	Peds quite distinct; more than two-thirds of the soil consists of peds	3

If different structure grades occur in different parts of a horizon, give the grade that is most common.

Type

Record the dominant ped type (shape) for each horizon using one of the following values:

Type	Description	Value to be used in scoresheet
Granular	spheroidal with limited accommodation to the faces of surrounding peds	GR
Platy	particles arranged around a horizontal plane, bounded by flat horizontal faces	PL
Prismatic	particles arranged around a vertical axis, bounded by well-defined, relatively flat faces	PR
Columnar	as for prismatic but with domed tops	COL
Angular blocky	particles arranged around a point, bounded by six relatively flat, roughly equal faces	ABK
Subangular blocky	particles arranged around a point, bounded by six flat and rounded, roughly equal faces	SBK
Single grained	loose, incoherent mass of individual particles	SGR
Massive	coherent; when displaced, soil separates into fragments	MA

In the case of compound structure, describe the larger structural type (shape). Soils that have no pedogenic structure (such as structure inherited from deposition) should be referred to as massive.

6. Consistence

Consistence is the resistance of a soil ped to deformation and is determined on a moist sample. Use one of the following abbreviations on the scoresheet:

Moist consistence	Criteria	Abbreviation
Loose	non-coherent	L
Very friable	crushes under very gentle pressure	VFR
Friable	crushes easily under gentle to moderate pressure between thumb and forefinger	FR
Firm	crushes under moderate pressure between thumb and forefinger but resistance is distinctly noticeable	FI
Very firm	crushes under strong pressure; barely crushable between thumb and forefinger	VFI
Extremely firm	crushes only under very strong pressure; cannot be crushed between thumb and forefinger and must be broken apart bit by bit	EFI

7. Redoximorphic features

Presence or absence

Redoximorphic (RMF) features are soil morphological features caused by alternating reduction/oxidation processes. The reduction/oxidation of iron (Fe) and, to a lesser extent, manganese (Mn), minerals result in most RMF features. 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 horizons. Iron or Mn reduction occurs when free oxygen is limited or excluded from a soil volume or horizon by water saturation for extended time. Reduced iron (Fe^{2+}) is comparatively much more soluble and mobile than oxidized iron (Fe^{3+}), and moves with water flow and by diffusion gradients. When soil is reduced, Fe and Mn in local zones can be removed, leaving uncoated mineral grains (depletions) of lighter color. Reduced Fe is oxidized and precipitates when water drains from soil (re-entry of free oxygen), or where oxygen is present in, or along, soil pores, including root channels, or along roots. The re-oxidized Fe or Mn may form crystals, soft masses, or hard concretions or nodules (concentrations). Oxidized Fe will generally have a redder or yellower color than adjacent soil particles, while Mn often will have a darker color than adjacent soil particles.

Redoximorphic features (RMF)	Value to be used in scoresheet
Present	P
Absent	A

Concentrations or depletions

Redox *concentrations* are defined as zones of Fe-Mn accumulation from:

Nodules and concentrations – concentrations have internal rings and nodules do not.

Masses – are non-cemented concentrations.

Pore linings – may be either coatings on pore surfaces or impregnations from the matrix adjacent to pores.

Redox *depletions* are defined as zones with chromas less than 2. They may be identified as:

Iron depletions – zones that contain lesser amounts of Fe and Mn oxides but have clay content similar to that of the adjacent matrix.

Clay depletions – zones that contain lesser amounts of Fe, Mn, and clay compared to the adjacent matrix.

Concentrations and depletions are present compared to the described, dominant soil matrix color in the hue, value, and chroma columns. If the dominant soil color is described as a depleted matrix (with a value of 2 or less) ***and*** concentrations are present, depletions should not be indicated in the (Conc/Dep) column and a ‘g’ should be used as the Master horizon suffix (e.g. Btg).

The Concentrations or depletions should be scored for each horizon as follows;

Type of redoximorphic features (RMF) present	**Value to be used in scoresheet**
Concentrations	CONC
Depletions	DEP
Concentrations and depletions	CONC/DEP
RMF absent	(–)

PART II: SOIL PROFILE CHARACTERISTICS

In Part II of the scoresheet, data from Part I is utilised to estimate various characteristics of the profile. For each of the five characteristics to be assessed, competitors are to place an 'X' in one box only. If more than one box is checked for any characteristic, zero points will be awarded for that characteristic.

1. Hydraulic conductivity

Estimate the saturated hydraulic conductivity of the surface horizon (*Surface*) and the most limiting horizon (*Limiting layer*) within the depth specified on the scoresheet. If a lithic or paralithic contact occurs at or above the specified depth, it should be considered in evaluating conductivity. Although unlikely, it is possible for the surface horizon to be the limiting horizon with respect to saturated hydraulic conductivity. In this event, the surface conductivity would be indicated as both the surface and limiting layer hydraulic conductivity.

Three general hydraulic conductivity classes are used:

High – includes sand and loamy sand texture classes. Sandy loam, sandy clay loam, silt loam and loam texture grades that are especially 'loose' because of very high organic matter content (>5% organic carbon) also fall into this category. Horizons containing >60% of coarse fragments with insufficient fines to fill voids between fragments are also considered to have high hydraulic conductivity.

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

Low – low hydraulic conductivity is indicated with any of the following:

- **i.** Clays, silty clays or sandy clays having structure grade of 0, 1 or 2.
- **ii.** Silty clay loams and clay loams that have a structure grade of 0 or 1.
- **iii.** Bedrock layers (Cr or R horizons) where the horizon directly above contains redoximorphic depletions or a depleted matrix due to prolonged wetness (value ≥4 with chroma ≤2).

2. Effective soil depth

Soil depth classes are defined as the depth from the soil surface to the upper boundary of a root restricting layer. Restrictive layers include:

- (i) horizons with coarse sand or rock fragment modified coarse sand textures with some unfilled voids located directly underneath a horizon of finer-textured soil materials (i.e., very fine sand, loamy very fine sand or finer texture);
- (ii) bedrock (lithic or paralithic materials);
- (iii) densic materials (not just horizons with d); and
- (iv) very firm or extremely firm SiC, C or SC texture grades that are structureless and massive. If the lower depth of judging is less than 150 cm, and there is no restricting layer within or at the judging depth, the horizon encountered at the bottom of the judged profile may be assumed to continue to at least 150 cm and 'very deep' should be selected.

3. <u>Available water holding capacity</u>

The available water holding capacity is approximately the water held between field capacity and permanent wilting point. The approximate amount of moisture 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 horizon or portion of horizon, if the horizon extends beyond 150 cm. If a horizon or layer is unfavourable for roots (as defined under effective soil depth), this and all horizons below should be excluded in calculating the available moisture. For available water calculations, the properties of the lowest horizon 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 horizon and the 150 cm depth, the depth to the restrictive layer should be considered for available water estimations. Four retention classes listed will be used:

Very low: <7.5 cm
Low: 7.5 to <15.0 cm
Moderate: 15.0 to <22.5 cm
High: ≥22.5 cm

The relationship between available water retained per centimetre of soil and the textures is given in the table below. Coarse fragments are considered to have negligible (assume zero) moisture retention, and estimates must be adjusted to reflect the coarse fragment content. If a soil contains coarse fragments, the volume occupied by the rock fragments must be estimated and the available water holding capacity corrected accordingly. For example, if a silt loam A horizon is 25 cm thick and contains rock fragments which occupy 10% of its volume, the available water-holding capacity of the horizon would be 25 cm × 0.20 cm/cm × [(100-10)/100] = 4.50 cm of water. Calculate the available water for each horizon to the nearest hundredth, sum all horizons, then round the grand total to the nearest tenth. For example, 14.92 would round to 14.9 in the low class; 15.15 would round to 15.2 in the moderate class.

Texture is an important factor influencing available water capacity, and the following estimated relationships are used:

Available Water Capacity (cm water per cm soil)	**Texture classes**
0.05	All sands, loamy coarse sand, loamy sand
0.10	Loamy fine sand, loamy very fine sand, coarse sandy loam
0.15	Sandy loam, fine sandy loam, sandy clay loam, sandy clay, clay, silty clay
0.20	Very fine sandy loam, loam, silt loam, silt, silty clay loam, clay loam

4. Soil wetness class

Soil wetness is a reflection of the rate at which water is removed from the soil by both runoff and percolation. Landscape position, slope gradient, infiltration rate, surface runoff, and permeability, are significant factors influencing the soil wetness class. Redoximorphic features, including concentrations, depletions and depleted matrix, are the common indicators of prolonged soil saturation and reduction (wet state), and are used to assess soil wetness class. The following determines the depth of the 'wet state':

(1) The top of an A horizon with:
  (a) Matrix chroma ≤2, and
  (b) Redoximorphic depletions or redoximorphic concentrations as soft masses or pore linings, and
  (c) Redoximorphic depletions or a depleted matrix due to prolonged saturation and reduction in the horizon directly below the A horizon, or

(2) The shallowest observed depth of value ≥4 with chroma ≤2 redoximorphic depletions or depleted matrix due to prolonged saturation and reduction.

The wetness classes utilized in this contest are those which define a 'depth to the wet state'.

Class	Description
1	Not wet above 150 cm depth
2	Wet in some part between 101 and 150 cm
3	Wet in some part between 51 and 100 cm
4	Wet in some part between 26 and 50 cm
5	Wet at 25 cm or shallower

If no evidence of wetness is present above a lithic or paralithic contact that is shallower than 150 cm, assume Class 1: not wet above 150 cm. If no evidence of wetness exists within the specified depth for judging and that depth is less than 150 cm, then assume Class 1: not wet above 150 cm.

PART III: SITE CHARACTERISTICS

Jeju island has an area of approximately 1850 km^2, being approximately 73 km long (WSW to ENE) and 31 km wide (NNW to SSE). The island is dominated by the Halla-san (Mt Halla) volcano, which has a height of 1950 m above sea level. The main rock types on the island are basalt, trachyte and trachybasalt.

1. Landform

Competitors must select one of the following landform morphological types for the location of the soil profile by marking with a cross (X); selection of two or more types will yield a score of zero for this attribute. Landform, or site position, will be judged between the slope stakes.

Summit – The topographically highest position of a hillslope profile with a nearly level (planar or only slightly convex) surface. Ridge tops are included under summit since they are topographic highs and are usually planar in one direction.

Shoulder – The hillslope profile position that forms the convex, erosional surface near the top of a hillslope. It comprises the transition zone from summit to backslope.

Backslope – This position includes all landscape positions between the shoulder and footslope.

Footslope – The constructional position that forms the concave surface at the base of a hillslope. In some landscapes, the footslope may gradually transition into a toeslope, where the toeslope gently transitions to a floodplain. For this contest, footslope and toeslope are constructional and will not be separated.

Plain – Planar landform element that is level or very gently inclined (Slopes less than 2 %). Plains will include floodplains, stream terraces with less than 2% slope, and depressions. Floodplains are the lowest geomorphic surface which is adjacent to the stream channel and which floods *first* when the stream goes into flood stage. It is formed by the deposition of alluvium. Each stream has only one floodplain. Stream terraces are geomorphic surfaces formed by the deposition of alluvium and are higher in elevation than the flood plain. A stream may have more one or more terraces. Depressions are low positions on the landscape where water and/or sediment accumulate. They have no free surface water drainage outlet.

2. Parent material

As Jeju island is a volcanic feature, the variety of possible soil parent materials is relatively limited. Competitors must select at least one of the following parent materials by marking with a cross (X). If more than one parent material is present, all should be recorded. If an option is selected that is not correct, 5 points will be deducted from the score for Parent material. Zero is the lowest score possible for Parent material.

Alluvium – is material transported and deposited by flowing water or in ponded depressions. It includes material on flood plains, stream terraces, alluvial fans, and at the base of slopes, drainage ways and depressions. Water is the primary mechanism of transport. Evidence of sorting by flowing water (stratification) may occur in several forms, including irregular variability of particle size with depth, especially of sand and rock fragment sizes. For example, thin strata (layers) of sandy textures alternating with silty textures, or a change from non-gravelly to extremely gravelly textures indicate irregular deposition due to variation in the velocity of flowing water. Rounded rock fragments sorted by size are also clues of movement by flowing water. In flooded areas, the soil may contain buried horizons and is coarser-textured nearest the active channel, becoming finer-textured away from the channel.

Ash/tephra – aeolian sediment consisting of relatively fine (<2 mm) pyroclastic material. It often contains a proportion of highly weatherable glass.

Colluvium – is poorly sorted material accumulated on, and especially at the base of, hill slopes. Colluvium results from the combined forces of gravity and water in the local movement and deposition of materials. Colluvium may contain a mixture of rock fragment types with variable size and orientation within a horizon, or it may contain a mismatch between rock fragments in upper horizons with those of horizons below that retain rock-controlled structure or in-place rock fragments below. Recently transported colluvium is typically found on backslope, footslope or toeslope slope profiles.

Human transported materials – is material moved and deposited by intentional human activity, usually with the aid of machinery. Common types of HTM include dredge deposits, construction debris, mine spoil, and other waste materials (ash, sludge, slag). These materials were intentionally collected and moved from one soil to another by human action, tools or machinery. These do not include material moved indirectly by human action, such as topsoil moved under accelerated erosion in farmland. The HTM are confirmed by the presence of artifacts, their occurrence on an evident human-constructed landform, or the evident burial of a natural soil below them on a human-constructed landform. Observed properties of HTM include disordered rock fragments, freshly fractured rock fragments with sharp or splintered edges, bridging voids between rock fragments, pockets of dissimilar materials, detached fragments of diagnostic horizons, buried artifacts, carbolithic materials, layers compressed by machinery, irregular distribution of organic matter, and the presence of strongly contrasting topsoil or underlying materials. The key to identification is ruling out deposition by natural forces or processes.

Residuum – is the unconsolidated and partially weathered mineral materials accumulated by disintegration of bedrock in place (*in situ* weathering).

3. <u>Slope</u>

The slope at should be determined with an Abney level or clinometer between two stakes at each site. The stakes may be of unequal height. Stakes are provided to assist competitors to measure the actual slope of the land between the stakes, not the slope at the top of the stakes. The height of the stakes should be compared and the actual soil slope measured. Competitors are to use a cross (X) for one slope category only. If a site falls on the boundary of two slope classes, mark the <u>steeper</u> class.

4. <u>Erosion</u>

Evidence of prior water erosion in the close vicinity of the soil pit and between the slope stakes should be assessed under the following categories. Competitors are to use a cross (X) for one category only.

None apparent –there is no evidence of erosion at the site.

Inter-rill – also known as sheet erosion, inter-rill erosion is the relatively uniform removal of soil from an area without the achievement of conspicuous channels. Indicators of sheet erosion include soil deposits in downslope sediment traps (e.g. fencelines, dams), and pedestalling, root exposure or exposure of subsoils.

Rill – a rill is a small channel up to 0.3 m deep, which can be largely obliterated by tillage operations.

Gully – a gully is a channel more than 0.3 m deep.

Tunnel – tunnel erosion is the removal of subsoil by water while the surface soil remains relatively intact.

PART IV: SOIL CLASSIFICATION

The Korean soil classification scheme follows *Soil Taxonomy*, although only seven Orders are found in Korea (Andisols, Alfisols, Entisols, Histosols, Inceptisols, Mollisols, Ultisols), and fourteen Suborders. On Jeju island all seven Orders are found, but the Andisols dominate, covering 73% of the land mass. In this contest, only areas containing **Andisols**, **Alfisols**, **Entisols**, **Inceptisols** and **Ultisols** will be used for practice and contest pits. These three orders are approximately equivalent to five Reference Soil Groups of the *World Reference Base for Soil Resources (WRB)* (**Alisols**, **Andisols**, **Cambisols**, **Luvisols**, **Umbrisols**).

Each competitor is to attempt either the first four columns relating to *Soil Taxonomy*, or the second set of four columns relating to the *WRB*. For each contest profile, the maximum possible points obtainable from the Soil Classification part will be the same for both the *Soil Taxonomy* and *WRB* parts.

If a competitor attempts both the *Soil Taxonomy* and *WRB* parts, only the *Soil Taxonomy* part answers will be marked.

Chemical data necessary for classification (e.g. to determine andic soil properties) will be provided at each pit on a pit card.

1a. Epipedon

Competitors are to use a cross (X) to select one epipedon type only. If more than one type is selected, no points will be awarded. See pp. 5–9 of the *Keys to Soil Taxonomy, Eleventh Edition (2010)* for definitions of the epipedon types. This document can be downloaded from;

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/?cid=nrcs142p2_053580

2a. Subsurface horizons

Competitors are to use a cross (X) to select as many of these five options that apply to the profile within the specified judging depth. Although *Andic properties* is not, strictly speaking, a subsurface horizon type or feature, it is included here because of its common occurrence in the soils of Jeju. Select this option if andic properties are evident anywhere in the specified judging depth.

If an option is selected that is not correct, 5 points will be deducted from the score for Subsurface horizons. Zero is the lowest score possible for Subsurface horizons.

In the *Keys to Soil Taxonomy, Eleventh Edition (2010)*, see pp. 10–11 for definitions of argillic and cambic horizons, p. 26 for the definition for lithic and paralithic contacts, and pp. 15–16 for the definition of andic soil properties.

3a. Order

Competitors are to use a cross (X) to select one soil order only. If more than one order is selected, no points will be awarded.

In the *Keys to Soil Taxonomy, Eleventh Edition (2010)*, see pp. 31–34 for the Key to Soil Orders, where orders are defined.

4a. Suborder

Competitors are to use a cross (X) to select one soil suborder only. If more than one suborder is selected, no points will be awarded.

In the *Keys to Soil Taxonomy, Eleventh Edition (2010)*, see p. 35 for Alfisol suborders, p. 77 for Andisol suborders, and p. 161 for Inceptisol suborders.

1b. Diagnostic horizon

Competitors are to use a cross (X) to select as many of these five diagnostic horizons that apply to the profile within the specified judging depth. See pp. 13-17, 24-25, and 37-38 of the *World reference base for soil resources 2006, First update (2007)* for definitions of the diagnostic horizons. This document can be downloaded from;

http://www.fao.org/fileadmin/templates/nr/images/resources/pdf_documents/wrb2007_red.pdf

If a diagnostic horizon is selected that is not correct, 5 points will be deducted from the score for Diagnostic horizon. Zero is the lowest score possible for Diagnostic horizon.

2b. Reference Soil Group

Competitors are to use a cross (X) to select one Reference Soil Group (RSG) only. If more than one RSG is selected, no points will be awarded.

In the *World reference base for soil resources 2006, First update (2007)*, see pp. 51–66 for the Key to the Reference Soil Groups, where the RSGs are defined.

3b. Prefix qualifier

Competitors are to use a cross (X) to select as many of these five prefix qualifiers that apply to the profile within the specified judging depth. If a qualifier is selected that is not correct, 5 points will be deducted from the score for Prefix qualifier. Zero is the lowest score possible for Prefix qualifier.

In the *World reference base for soil resources 2006, First update (2007)*, see pp. 97–107 for the definitions of the Prefix qualifiers. Note that Andic, Vitric and Haplic are all mutually exclusive.

4b. Suffix qualifier

Competitors are to use a cross (X) to select as many of these five suffix qualifiers that apply to the profile within the specified judging depth. If a qualifier is selected that is not correct, 5 points will be deducted from the score for Suffix qualifier. Zero is the lowest score possible for Suffix qualifier.

In the *World reference base for soil resources 2006, First update (2007)*, see pp. 97–107 for the definitions of the Suffix qualifiers.

PART V: INTERPRETATIONS

1. Tangerine production

Ninety-nine percent of Korea's tangerine production occurs on Jeju island. The tangerine (*Citrus tangerina*) is a citrus fruit which is closely related to the mandarin, and its production on Jeju is largely related to the more southerly latitude and warmer climate of the island than the rest of mainland Korea. The optimal temperature for tangerine growth is 15–16°C, and the mean annual air temperature on Jeju is 15.3°C.

The suitability of soil for tangerine production on Jeju is assessed using the following table, with the most limiting factor of any of the seven soil attributes used to allocate a soil to a suitability class. Competitors are to use a cross (X) to select one suitability class.

	Class 1 Optimal	**Class 2** Suitable	**Class 3** Unsuitable
Texture class	LS, SL, L, SIL, SI, SCL, CL, SICL	C, SIC, SC	S
Slope (%)	<15	15–30	>30
Gravel (%)	<35	>35	–
Drainage	Very good to good	Moderate	Slow to very slow
Depth to root restriction (cm)	>50	20–50	<20
Colour of topsoil	Brown (7.5YR and yellower: V/C = all between 2/3, 5/3, 2/8, 5/8)	Black (any hue: V/C = 2/1 to 3/1, 2/2 to 3/2) Red (5YR and redder: V/C = all between 2.5/3, 8/3, 2.5/8, 8/8)	White (any hue: V/C = 8/1) Grey (any hue: V/C = 4/1 to 7/1, 4/2 to 7/2)
Erosion	Little or none	High	Very high

Notes: *Drainage* should be assessed by comparison with the *Limiting layer* hydraulic conductivity in Part II.
Assume: Very good to good = High, Slow to very slow = Low

Texture class, *Gravel (%)* and *Colour of topsoil* all relate to the thickest horizon in the top 20 cm of the profile

2. Carrot production

Seventy percent of Korea's carrot production occurs on Jeju island. To assess the suitability of land for carrot production, a range of soil and land features are assessed using a simple scoring system. For each of the five soil and land features given in the table below, assign the profile to one of the four classes, tally up the points for each feature and determine the overall Class based on total points accumulated.

Competitors are to use a cross (X) to select one suitability class.

	Class 1 Optimal	**Class 2** Suitable	**Class 3** Possible	**Class 4** Unsuitable
Score	**20 pts**	**15 pts**	**10 pts**	**5 pts**
Topsoil texture class	LS, SL, L, SIL, SI	CL, SICL, SCL	C, SIC, SC	S
Slope (%)	2–7	0–2	7–15	>15
Gravel (%)	<10	10–35	–	>35
Drainage	Good	Moderate	–	Slow, very slow
Effective soil depth (cm)	>100	50–100	20–50	<20
Total score	**≥85**	**80**	**70, 75**	**<70**

Notes: *Texture class* and *Gravel (%)* relate to the thickest horizon in the top 20 cm of the profile

Gravel (%) should be compared to the *Coarse fragment (%)* assessed during the *Texture class* assessment in Part I.

Drainage should be assessed by comparison with the *Limiting layer* hydraulic conductivity in Part II.
Assume: Good = High, Slow to very slow = Low

3. Golf course suitability

A prominent part of Jeju island's economy is its tourism industry, and golf courses are an important tourist attraction. Different parts of the landscape are more suited to the construction and maintenance of golf courses than others, due mainly to soil drainage considerations.

The suitability of topsoil for lawns and golf courses on Jeju is assessed using the following table, with the most limiting factor of any of the ten soil and land attributes used to allocate a soil to a limitation class. For each soil attribute listed, competitors are to consider only the major (thickest) A horizon.

Competitors are to use a cross (X) to select one limitation class.

Topsoil or land attribute	**Limitation class**		
	Slight	Moderate	Severe
Slope (%)	<8	8–15	>15
Depth to bedrock (m)	>1.8	1–1.8	<1
Texture class	–	LCOS, S	SIC, C, SC, COS
EC_{SE} (dS/m)	<4	4–8	>8
Sodium Adsorption Ratio (SAR)	–	–	>12
pH	–	–	<3.5
Available water (cm/cm)	>0.10	0.05–0.10	<0.05
Content of >7.5 cm stones (%)	<25	25–50	>50
Depth to groundwater (m)	>1.5	0.65–1.5	<0.65
Flooding	None	Sometimes	Frequent

Notes: EC_{SE} and *SAR* data will be provided on pit cards at each pit.

4. Septic tank suitability

Due to the prominence of tourism on Jeju, another important consideration is sewerage treatment. The suitability of soil for septic tank installation on Jeju is assessed using the following table, with the most limiting factor of any of the seven soil and land attributes used to allocate a soil to a limitation class. Competitors are to use a cross (X) to select one limitation class.

Characteristics	**Limitation class**		
	Slight	Moderate	Severe
Total subsidence (m)	–	–	>1
Flooding	None	Seldom	Usual
Depth to bedrock (m)	>1.8	1–1.8	<1
Depth to groundwater(m)	>1.8	1.2–1.8	<1.2
Percolation rate between 0.6-1.5 m	High	Moderate	Low
Slope (%)	<8	8–15	>15
Content of >7.5 cm cobbles (%)	<25	25–50	>50

Notes: *Percolation rate* should be assessed by comparison with the *Limiting layer* hydraulic conductivity in Part II.

Content of >7.5 cm cobbles is a weighted average to a depth of 1.0 m.