FAO - UNESCO PROYECT

Third South American Soil Correlation Meeting for the Soil Map of the World

Buenos Aires

A R G E N T I N A

december 1966

Viaje de Correlación de Suelos por la Región Pampeana
(Soil Correlation trip through the Pampean Region)

PROGRAMA DE VIAJE
(Field Tour Program)

Prepared by P.H. Etchevehere and J.C. Musto

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RASGOS FISICOS DE LA REGION PAMPEANA

prepararon: geólogos J.A. Ferrer y B. Jarsun

En la República Argentina se conoce con el nombre de "pampa" a una amplia llanura de una extensión aproximada de 500.000 km^2, que puede situarse entre los paralelos 31° y 39° S y los meridianos 57° y 65° W. Comprende las provincias de Buenos Aires, E. de La Pampa, SE de Córdoba, S de Santa Fe y, para algunos autores, la provincia de Entre Ríos.

Constituye una región en general uniforme y monótona, aunque es posible reconocer varias subregiones de distintas condiciones debidas a movimientos diferenciales de las estructuras profundas (ver mapa N° 1). Existe un área ondulada al N de la provincia de Buenos Aires, que limita en forma abrupta con un ambiente deltaico formado por el río Paraná. En el centro-este hay un sector negativo ("pampa deprimida"); hacia el W una gran área semiárida, de relieve medanoso con costras calcáreas; hacia el S, dos sistemas montañosos constituidos por las sierras de Tandil y la Ventana. La región limita al W con otro sistema orográfico, el de Córdoba y San Luis.

La pendiente general es muy suave; toda la pampa se halla por debajo de la cota 200 m, excepto en las sierras y pedemontes.

La red de drenaje es pobre; los ríos y arroyos tienen valles asimétricos planos, anchos, poco profundos y meandrosos. En el W las aguas se infiltran en los materiales arenosos; en el área deprimida existe un verdadero rosario de lagunas. Los excedentes de agua se ven dificultados para llegar al mar por la escasa pendiente y por cordones costaneros de conchillas que forman una barrera natural; en

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años lluviosos provocan inundaciones. Los cursos principales de la pampa son el río Salado y su sistema, y el Carcarañá, éste último formado por el Tercero y el Saladillo, receptor de las aguas del río Cuarto, en Córdoba.

La mayor concentración de vías de agua se halla en la "pampa ondulada", al norte del río Salado, que en su mayor parte desagua al Paraná. En esta red se observan anomalías en su rumbo, lo que indica cierto control estructural.

Al W de Buenos Aires, SE de Córdoba y E de La Pampa, existe una amplia área arreica con abundantes lagunas, en su mayoría saladas. El río Quinto -único curso del área-, se insume al S de Córdoba. Bordeando este sector por el sur y con dirección SW - NE, corre el arroyo Vallimanca, cuyo valle se encuentra en una depresión de carácter tectónico ; cuando aumenta su caudal vuelca sus aguas al Salado.

Al S de Buenos Aires la red está formada por numerosos arroyos de corta extensión, que bajan de las sierras y corren en su mayor parte al Atlántico.

GEOLOGIA.- La región pampeana está constituída por el relleno de un antiguo "graben" de bloques tectónicos fracturados . Por esta razón el basamento cristalino se encuentra a distintas profundidades: en la ciudad de Buenos Aires a 290 m, a sólo 120 km al S, en la ciudad de General Belgrano, se lo encuentra a 5.000 m de profundidad, mientras que aflora en las sierras ya citadas. Estas están constituidas por gneisses, migmatitas y calizas. Existen rocas del Precámbrico, areniscas cuarcíticas del Devónico y tillitas, pizarras y conglomerados glaciales del Pérmico.

Sedimentos terciarios se encuentran rellenando la fosa del Salado, en la Sierra de la Ventana y en mesetas de la provincia de La Pampa. Casi todo este viejo paisaje se halla cubierto por sedimentos cuartarios; en las terrazas altas, "pampiano" y en las terrazas bajas "postpampiano". El

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pampiano está representado por sedimentos loéssicos franco-limosos y limos, mientras que las depresiones lacustres y terrazas bajas poseen materiales limosos y arcillo-limosos post-pampianos.

MATERIALES ORIGINARIOS DE LOS SUELOS.- El citado manto de sedimentos eólicos y fluviolacustres del Cuartario constituye, en su casi totalidad, los materiales de origen de los suelos pampeanos. La textura de estos sedimentos superficiales se va haciendo más gruesa de E a W, por lo que ganan en fracción arcilla cerca del litoral. Son en general ricos en calcáreo y en minerales meteorizables en arcilla. Análisis mineralógicos recientes han revelado que en la fracción liviana de los sedimentos superficiales hay preponderancia de plagioclasa y vidrio volcánico; y en la fracción pesada, piroxenos, magnetita, ilmenita y en menor cantidad hornblenda, lo cual indica la intervención de materiales de origen volcánico en la evolución de los suelos pampeanos.

CLIMA.- Al E de la región pampeana el clima es templado sub-húmedo, con régimen típico de estepa, sin períodos netamente secos. Al W es semi-árido; junio-julio son los meses menos lluviosos.

Las precipitaciones medias anuales, oscilan entre 600 y 1000 mm; aumentan de SW a NE; los registros máximos corresponden a primavera y otoño, pero ninguna estación es marcadamente lluviosa. El déficit de humedad, determinado por Burgos y Vidal según la fórmula de Thornthwaite, da valores desde 0 hasta 400 mm. (Ver mapas adjuntos).

Las temperaturas medias aumentan levemente de S a N: 14°C en el S y 18°C en el N de la región; las variaciones estacionales son menos pronunciadas en el litoral marítimo (12°C) que en la parte continental (16°C).- La tempera-

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tura media del mes más frío oscila entre 8° y 12°C y la del mes más cálido entre 20°C y 26°C. La amplitud diaria es de unos 10°C al este y de 15° al oeste.

Las nevadas son excepcionales, habiéndose registrado entre 1 y 2 días al año en Río Cuarto, Bahía Blanca, Mar del Plata, sierra de La Ventana, etc.; en ningún momento el suelo se llega a cubrir de nieve.

El período anual libre de heladas oscila entre 200 y 300 días, siendo la última helada primaveral a mediados de octubre, aunque no es raro que ocurra en el mes de noviembre, mientras que las primeras heladas otoñales se producen a fines de abril (Ver mapas N°s. 2 a 8).

VEGETACION NATURAL.- (Resumido de A.L. Cabrera, "Esquema fitogeográfico de la República Argentina")

La vegetación natural de la pampa argentina se encuentra casi enteramente alterada por la ocupación humana. No obstante, ha sido posible reconocer dos "provincias fitogeográficas" caracterizadas por fisonomías distintas: la "Pampeana y la del Espinal" (ver mapa N° 9).

P) Provincia fitogeográfica pampeana: Vegetación dominantemente graminosa, de tipo estepario. Aunque la estepa climax ha sido destruida casi totalmente, se han reconocido cuatro distritos cuyas especies domiantes son :

P1) distrito uruguayense, con Eragrostis megastachya, Poa lanigera, Briza triloba y varias especies del género Stipa.

P2) distrito pampeano oriental, con un período de reposo en pleno verano y por lo general otro en invierno. Las gramíneas nativas eran cespitosas y formaban matas de hasta

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80 cm en primavera. Las más frecuentes son las "flechillas": Stipa neesiana, Piptochaetium montevidense, Stipa papposa, S. charruana, S. bavioensis, etc.

P3) distrito pampeano occidental. Con clima más seco y suelo arenoso, sin cursos de agua y cuencas generalmente salobres. La estepa climax está constituida por Stipa latissimifolia, S. ichu, S. trichotoma y otras.

P4) distrito pampeano austral. Abarca una estepa, con bosquecillos xerófilos en las sierras. El clima es algo más seco y más frío. Dominan matas de Stipa de hojas enroscadas.

E - Provincia fitogeográfica del Espinal.- rodea como un arco a la estepa pampeana; la vegetación dominante es un bosque xerófilo de leguminosas mimosoideas espinosas ("espinal") y sabanas arbustivas. Se han distinguido cuatro distritos, caracterizados por el dominio de cierta especie característica:

E1 - distrito del Ñandubay - se caracteriza por Prosopis algarrobilla ("ñandubay"), árbol de cinco a ocho metros de altura, asociado a Acacia caven, Geoffroea (= gourleia) decorticans ("chañar"), y otras.

E2 - distrito del Algarrobo: estos bosques han sido explotados totalmente para librar la región a la agricultura. Parece que las especies dominantes han sido Prosopis alba y P. nigra ("algarrobo" blanco y negro).

E3 - distrito del Caldén - es un bosque xerófilo en el que domina Prosopis caldenia ("caldén"), árbol de 8 a 12 metros de altura, muy explotado.

E4 - distrito del Tala - abarca las barrancas del río Paraná, bancos de conchillas del litoral y dunas estabilizadas costeras. La especie dominante es Celtis spinosa ("tala").

SUELOS PREDOMINANTES (según P.L. Arens y P.H.Etchevehere)

En distintos estudios y bosquejos de la región pampeana se han reconocido diversos suelos cuyos grandes grupos dominantes se enumeran a continuación. El orden numérico hace referencia a las regiones de suelos del mapa Nº 10.

1 - Brunizem con horizonte B2t bien desarrollado (Argiudoles).

2 - Brunizem con horizonte B2t débilmente desarrollado o sin horizonte B2t (Hapludoles).

3 - Grumusoles y Brunizem con horizonte B2t (e intergrados).

4 - Brunizem planosólicos, Planosoles y otros suelos hidromórficos, algunos con fragipán (Argialboles, Argiacuoles, Fragacualfs).

5 - Suelos gley (húmicos y subhúmicos) con y sin horizonte petrocálcico ("tosca") y otros suelos halo e hidromórficos (Argiacuoles, Argialboles, Duracuoles, Natralboles, Natracuoles).

6 - Brunizem (algunos someros) con B2t bien desarrollados y con horizonte petrocálcico (Argiudoles líticos, Argiudoles típicos, Argiudoles petrocálcicos, Rendoles, Durudoles háplicos).

7 - Brunizem sin B2t o con B2t débilmente desarrollado y con horizonte petrocálcico (Hapludoles petrocálcicos).

8 - Brunizem regosólicos y Regosoles en su mayor parte sobre arenas (Hapludoles y Haplustoles énticos y típicos, Psamustents, Orthopsaments).

9 - Brunizem hidromórficos con horizonte petrocálcico y alcalinos asociados. (Duriacuoles y Calciacuoles, Natracuoles, etc.).

10 - Brunizem con B2t (a veces enterrado por un suelo Brunizem regosólico); Planosoles con y sin fragipán y Brunizem planosólicos (Bisequas Hapludol sobre Argiudol o sobre Argiacuol, Fragiacuoles, Argiacuoles cálcicos y nátricos, Calciacuoles, etc.

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11 - Castaños y Castaños regosólicos, con y sin horizonte petrocálcico (Haplustoles típicos, énticos y petrocálcicos).

12 - Castaños hidromórficos (Haplacuoles típicos, dúricos, psaméńticos, y Haplustoles ácuicos).

13 - Pardos cálcicos y Pardos regosólicos, con y sin horizonte petrocálcico (Calciustoles típicos, petrocálcicos, háplicos; Haplustoles arídicos, cumúlicos y petrocálcicos, Calciortids, etc.

14 - Aluviales asociados con salinos, alcalinos o hidromórficos.

15 - Regosolos y dunas arenosas.

16 - Litosoles y afloramientos rocosos.

PRINCIPALES CULTIVOS; SU DISTRIBUCION Y RENDIMIENTO (preparado por el Ing.Agr. J.C. Musto).

La fertilidad natural y facilidad de labranza de los suelos pampeanos, las buenas condiciones ecológicas y la vegetación natural predominante de gramíneas forrajeras, favorecieron una rápida expansión de los cultivos cerealeros y el gran desarrollo ganadero del país.

La enorme expansión agrícola de la región pampeana iniciada en la última década del siglo pasado se apoyó principalmente en los cultivos de trigo y maíz, aunque sin desconocer la importancia de los otros cereales forrajeros y del lino.

En los gráficos que siguen se bosquejan para cada cultivo las regiones productoreas diferenciadas por rendimientos y condiciones ecológicas.

1.- Maíz

El corazón maicero tradicional argentino comprende el norte de Buenos Aires, sur de Santa Fé y este de Córdoba, abarca las áreas de mejores condiciones para este cereal por sus condiciones de suelo, lluvia y facilidad de comercializa

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ción. El área sembrada con maíz fluctúa alrededor de 3.500.000 hectáreas.

En la actualidad el 70-80% de las siembras se hacen con maices híbridos principalmente del tipo flint.

2.- Trigo

La gran región triguera argentina, considerada como una de las mejores del mundo, para la producción triguera, cubre un área sembrada de alrededor de 7.000.000 de hectáreas, los que incluye las provincias de Buenos Aires, Santa Fé, Entre Ríos, Córdoba, Sudeste de Santiago del Estero y La Pampa.

La Provincia de Buenos Aires ocupa el primer puesto con alrededor de 2.500.000 hectáreas sembradas y 2.600.000 toneladas de producción anual.

Las variedades sembradas son en su gran mayoría del tipo "duro" y "semiduro", siendo muy escaso las variedades del tipo "fideos".

3.- Girasol

Cultivo muy difundido en la República Argentina cubre una superficie de más de un millón y medio de hectáreas, correspondiendo a la región pampeana más del 75% de esa área.

Los cultivos sembrados tempranos (primera siembra) obtienen los mayores rendimientos, como consecuencia de la mejor preparación del suelo y mayor disponibilidad de agua, lo que les permite resistir mejor las condiciones de sequía estacionales de verano (0.8 Tn a 2.0 Tn).

Los cultivos que siguen inmediatamente al cultivo de trigo (girasol de segunda cosecha), sembrados tardíamente, rinden menos y su éxito está supeditado a las precipitacio

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nes estivales (0.5 - 0.8 Tn).

4.- Lino

De los dos tipos de lino cultivados, oleaginoso y textil, el primero es el que ocupa la mayor superficie de siembra. El área total sembrada de lino fluctúa alrededor de 1.100.000 hectáreas.

Los rendimientos para el lino oleaginoso oscilan entre 600 y 800 kg/ha.

El lino textil rinde en condiciones normales de secano de 3 a 4000 kg de paja por hectárea.

5-6-7.- Cereales forrajeros: Avena -Cebada forrajera-Centeno.

La provincia de Buenos Aires, Sur de Santa Fe y Este de La Pampa constituye la principal zona productora de estos cereales de invierno. La mitad de la producción de avena y casi la totalidad de la de cebada y centeno, se destina a su aprovechamiento exclusivo para pastoreo del ganado y el resto se emplea con fines de doble propósito (pastoreo y grano). La cebada cervecera se cultiva en el sur de la provincia de Buenos Aires.

8.- Alfalfa

Es la especie forrajera más importante de la región pampeana por sus óptimas condiciones como forrajera y su aptitud como recuperadora de suelos cansados.

En la República Argentina se cultiva aproximadamente 7.000.000 de hectáreas con ésta forrajera, sola o consociada con gramíneas.

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Su duración y rendimiento varía según zonas ecológicas y manejo, con bastante amplitud.

9.- Papa

Este cultivo se puede realizar en casi toda la región pampeana, pero está concentrado en determinadas regiones por sus condiciones ecológicas y económicas.

Las principales regiones son : 1) Zona Sudeste de la Provincia de Buenos Aires; 2) Zona Rosario y 3) Zona oeste de la Provincia de Buenos Aires.

El área total sembrada con papas fluctúa alrededor de 250.000 hectáreas.

Generalmente se cultiva en rotación siguiendo a la alfalfa o sobre campos naturales con dos o tres años de descanso (Barbecho con vegetación natural).

10.- Pradera natural y sembrada.

La región pampeana es la zona del país que posee praderas naturales de mayor valor forrajero, con asociaciones valiosas integradas por Lolium multiflorum (Rye grass criollo); Bromus unioloides (cebadilla criolla); Medicago híspida; Medicago arábica (tréboles de carretilla); Paspalum dilatatum (pasto miel), etc , etc. En las praderas naturales muchas especies del género Stipa prevalecen.

La disminución de las lluvias que se opera hacia el Oeste, hace sentir su influencia en la calidad de las pasturas.

Las pasturas artificiales más comunes para la "pampa húmeda" (más de 700 mm de lluvia anual) son a base de alfalfa (Medicago sativa); trébol de olor blanco y amarillo

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(Melilotus albus y officinalis); trébol rojo (Trifolium pratense); trébol blanco (Trifolium repens; Pasto ovillo (Dactylis glomerata); Festuca (Festuca arundinacea); Falaris de los bañados (Phalaris arundinacea);Falaris bulbosa (Phalaris tuberosa); Agropiro alargado (Agropyron elongatum), etc.

Para la región semiárida y sub-húmeda pampeana (menos de 700 mm de lluvia anual) las pasturas artificiales sembradas están integradas por : Alfalfa (Medicago sativa);trébol de olor amarillo y blanco (Melilotus albus y Officinalis); Agropiro alargado y crestado (Agropyron elongatum y cristatum), Cebadilla criolla (Bromus unioloides); Cebadilla pampeana (Bromus brevis); Festuca alta(Festuca arundinacea); Grama Rhodes (Chloris Gayana); Pasto llorón (Eragrostis curvula); Falaris Bulbosa (Phalaris tuberosa); Sorgo negro (Sorghum almun), etc, etc.

Se estima que la región pampeana incluye alrededor de 40.000.000 de hectáreas de praderas, de las que en la actualidad alrededor de 1.000.000 de hectáreas son pasturas sembradas y alrededor de 8.000.000 de hectáreas sembradas de forrajes.

FORMAS DE EXPLOTACION GANADERA Y SU DISTRIBUCION PREDOMINANTE.

11.- Vacunos

De los 2.790.485 km^2 de la República Argentina (Porción continental americana incluída Islas Malvinas),la tercera parte son favorables para la cría de bovinos puros y de elevada mestización, medio millón más de kilómetros cuadrados pueden destinarse a la cría de ganado criollo.

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En la Región Pampeana todas las razas que se crian son puras o de alta mestización.

En zona A: Se cría con razas perfeccionadas de carne Shorthorn, Hereford, y Aberdeen Angus.

En zona B: De inverne (de la producción de la zona A) con los productos de las mismas razas).

En zona C: Tambera con razas Holando-Argentino y Shorthorn Lechero.

En zona D: Cría e invernada con Shorthorn, Hereford y Aberdeen Angus.

12.- Ovinos

En la Región Pampeana se crian razas productoras de lana fina, carne y doble propósito. Las principales razas son : Merino Argentino y Merino Australiano como productores de lana fina; Corriedale, Romney Marsh y Lincoln, dentro de la aptitud dual y Southdown, Hampshire Down y Black Face entre las productoras eminentemente de carne.

PHYSICAL CHARACTERISTICS OF THE PAMPEAN REGION

(prepared by J.A.Ferrer and B.Jarsun)

The Argentine "pampa" is a vast plain covering about 500.000 square kilometers, located approximately between parallels 31° and 39° S.L. and meridians 57° and 65° W.L. It includes the Provinces of Buenos Aires, the eastern part of La Pampa, the south-eastern part of Córdoba and the southern part of Santa Fé, as well as Entre Ríos.

In general the pampa is a uniform and homogeneous region; however it is possible to distinguish various sub-regions where different conditions prevail, due to differential movements of the deep substratum (see map of physiographic units).

In the northern part of Buenos Aires the so-called undulating pampa stretches out, limited by the Paraná river and its delta. In the eastern-central part an area of subsidence is found, commonly referred to as the depressed pampa. In the western part a large semi-arid area occurs, characterized by sand dunes and limestone crusts. In the southern part two low mountainous systems arise, made up of the pampean sierras of Tandil and La Ventana.

Slopes in general are very gentle and, with the exception of the sierras and its piedmonts, the height above sea level is less than 200 m in all of this area.

The drainage network is rather poorly developed in great parts of the area. In the western part the (scarce) rainfall infiltrates in the rather sandy materials without an outlet to the sea. In the depressed pampa a chain of lakes exist and drainage is impeded by lack of slope and by the presence of a natural barrier in the

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form of marine shell ridges. The principal drainage way of this part of the pampa is the Rio Salado system with its tributaries. In the undulating pampa a major concentration of water ways is observed, draining mostly toward the Paraná river.

In the southern part of Buenos Aires Province a well developed network of short rivers exists, draining toward the Atlantic Ocean.

GEOLOGY.- Nearly the whole pampean region is covered with Quaternary sediments of considerable thickness that form the present surface. These so-called pampean sediments are represented by loess-like materials ranging in texture form siltloams to silty clayloams and loams. In lacustrine depressions and along streams and rivers somewhat finer textured materials have been deposited (post-pampean) ranging from clayloams to loams.

All these materials, together with sediments of tertiary age, have filled a large "graben" made up of fractured blocks of the southern periphery of the Brasilian shield. The basement rocks, constituted by gneisses and migmatites, are found at various depths: at about 290 m. below the city of Buenos Aires, at 5000 m depth below the city of General Belgrano, 120 km to the south of B.A. and at the surface again in the pampean sierras of Tandil and La Ventana.

SOIL PARENT MATERIALS.- The eolian and fluvio lacustrine sediments of the pampean formation form the parent materials for the soils of the pampean region. The texture of these materials varies in E-W direction, being finer textured toward the east and coarser toward the west. In general these materials are somewhat calcareous and rich in easily weatherable

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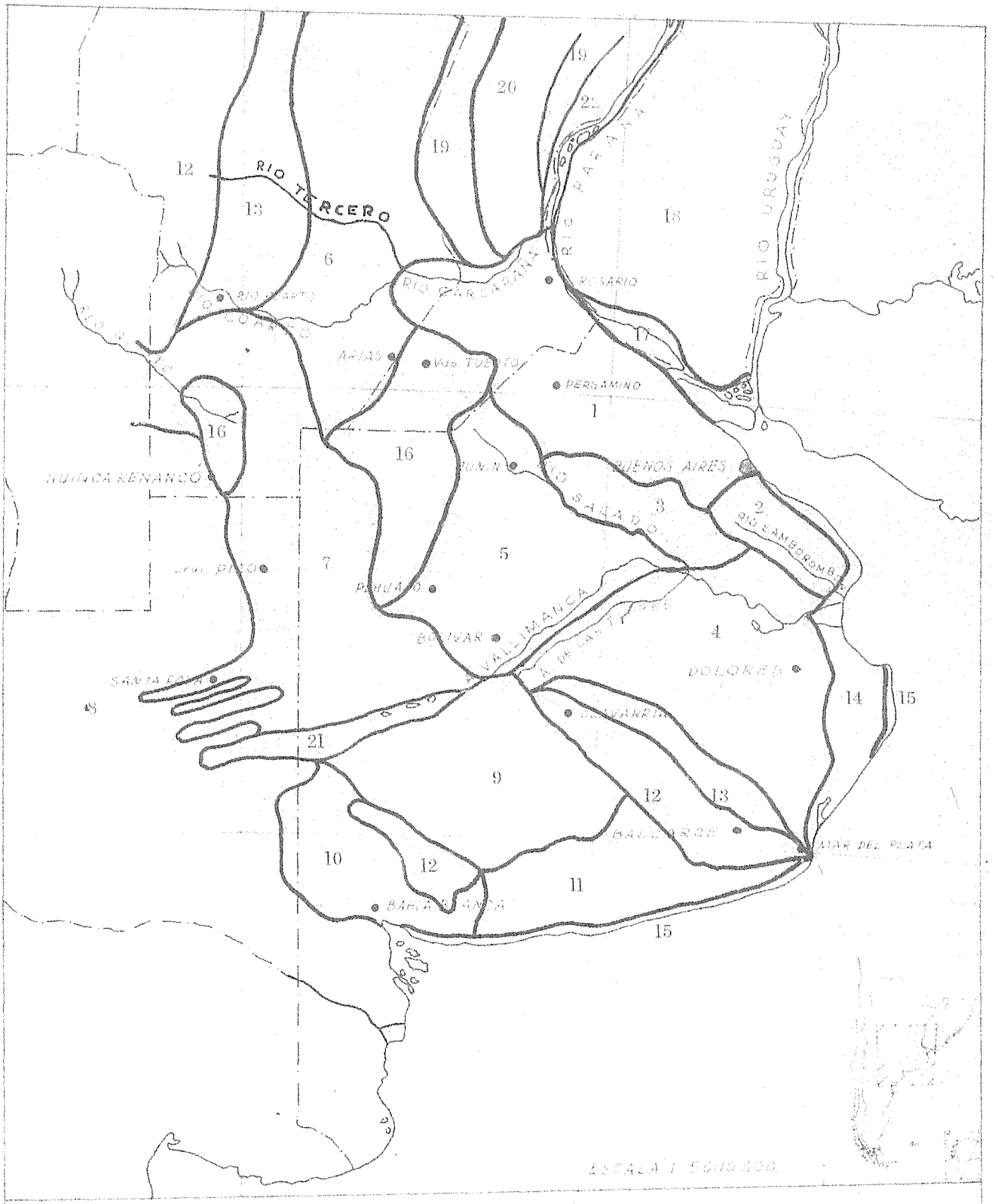
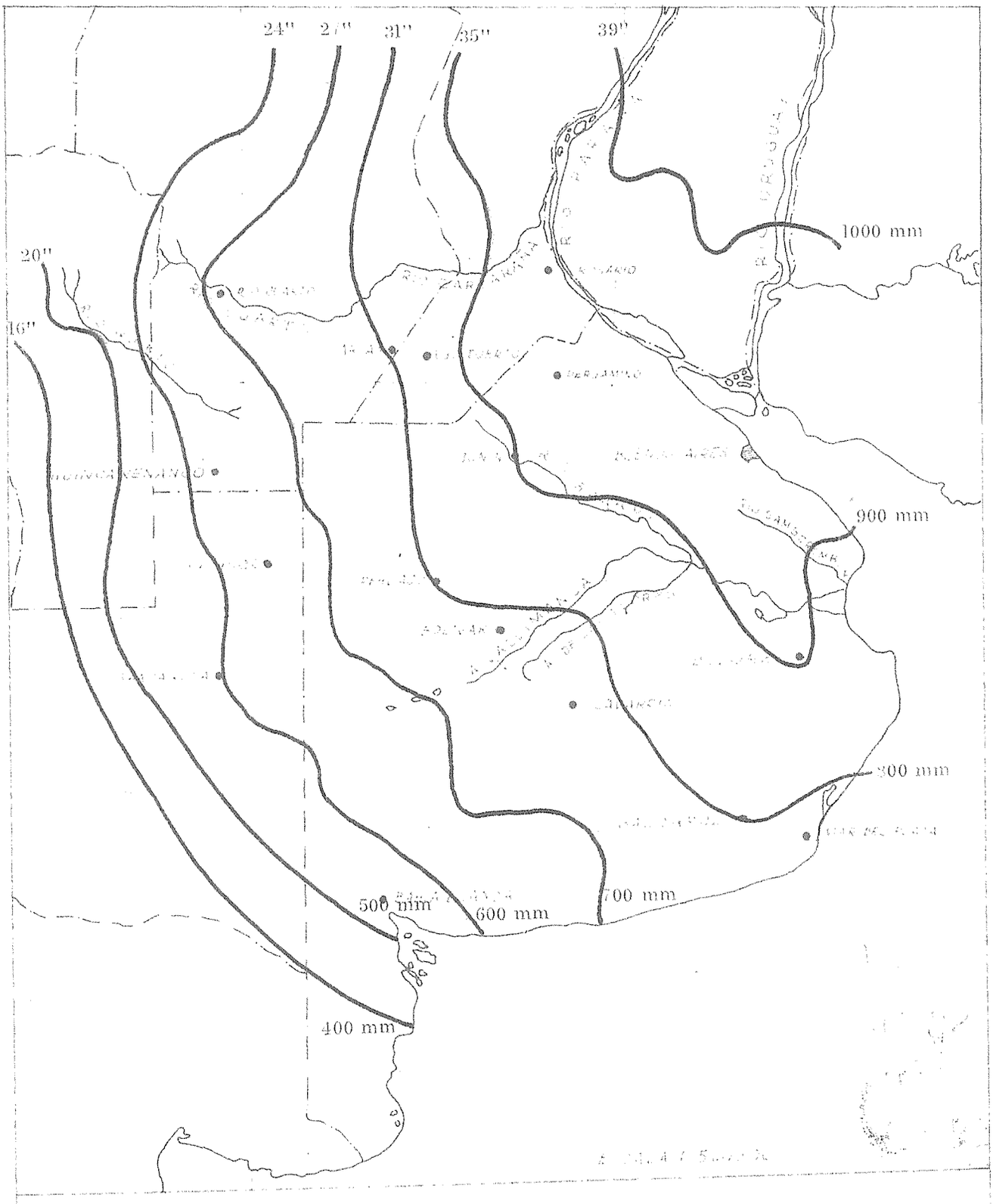


GRANDES UNIDADES FISIOGRAFICAS DE LA REGION PAMPEANA

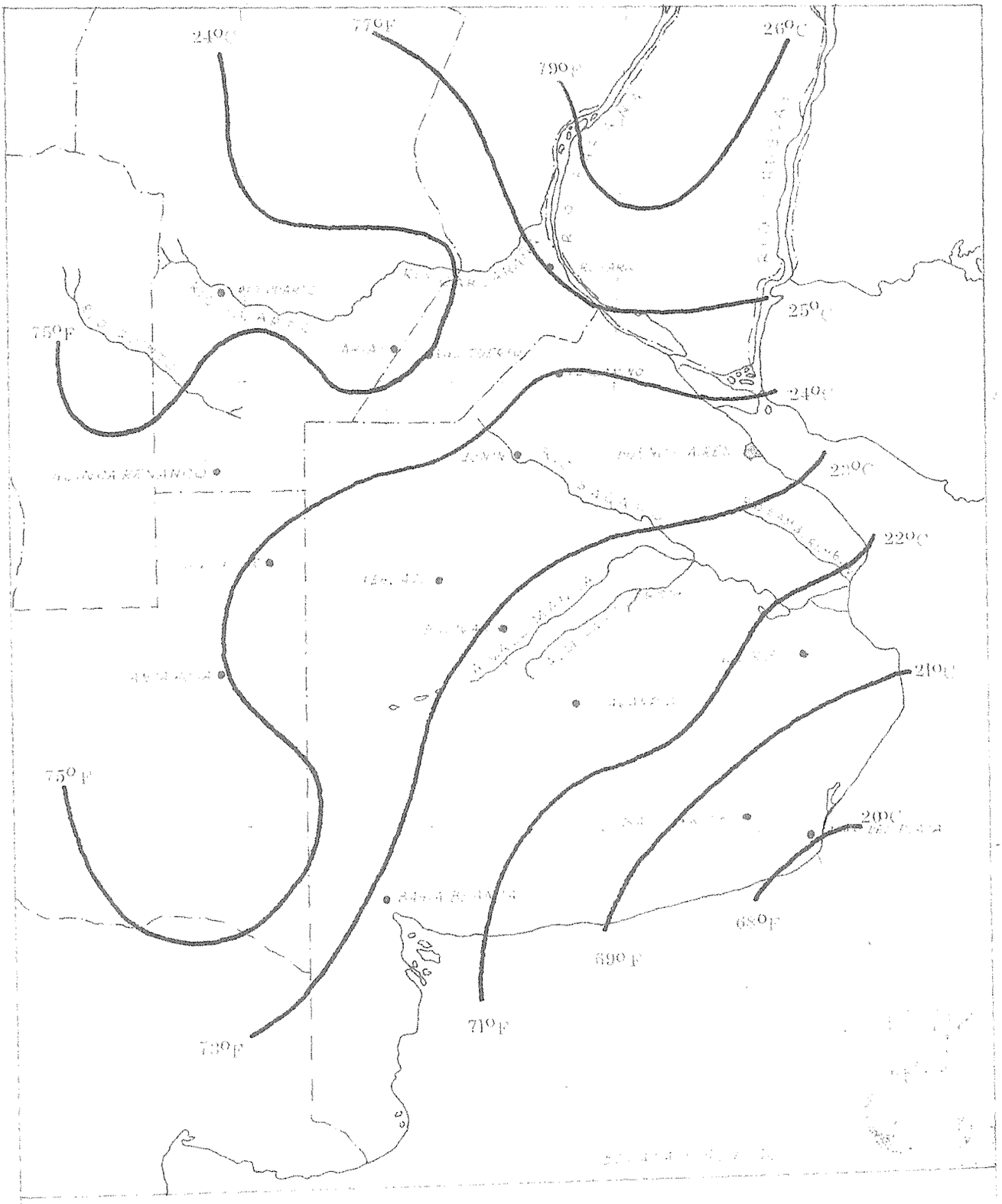
PHYSIOGRAPHIC UNITS OF THE PAMPEAN REGION

1 Undulating pampa
2 Low pampa
3 Flat pampa
4 Depressed pampa
5 Western sandy pampa
6 Cordoba plains
7 Drift sands pampa
8 Pampean plateau
9 Inter-mountain pampa
10 Southwestern pampa
11 South atlantic pampa
12 Pampean sierras
13 Mountain piedmonts
14 Coastal low terrace
15 Marine dunes
16 Internal drainage basins
17 Paraná delta
18 Entre Rios region
19 Santa Fe flexures
20 Central flat plain of Santa Fe
21 Carhué depression
22 Alluvial plains of Santa Fe



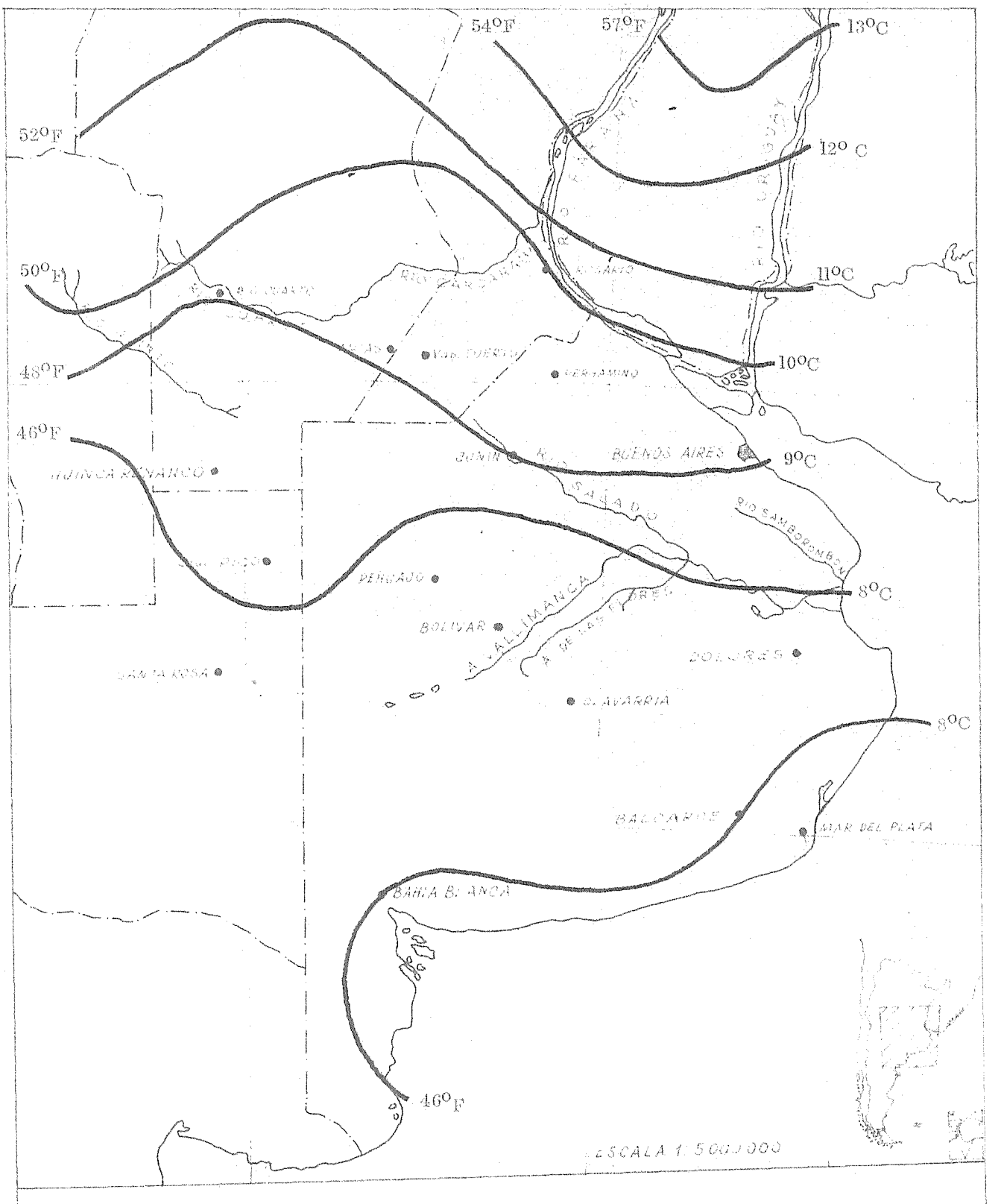
PRECIPITACION MEDIA ANUAL (1921-1950)

MEAN ANNUAL PRECIPITATION



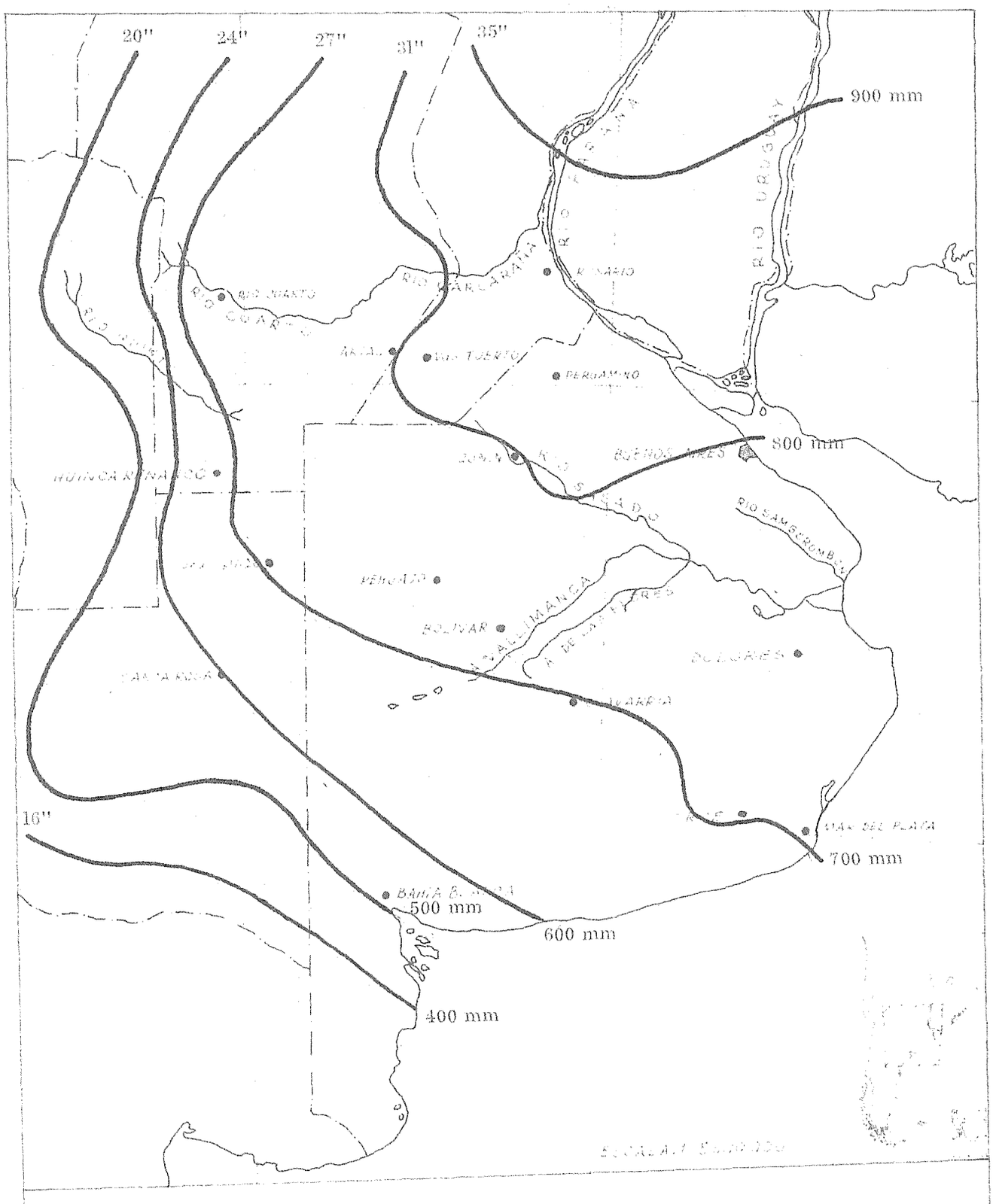
TEMPERATURAS MEDIAS DE ENERO

AVERAGE JANUARY TEMPERATURE



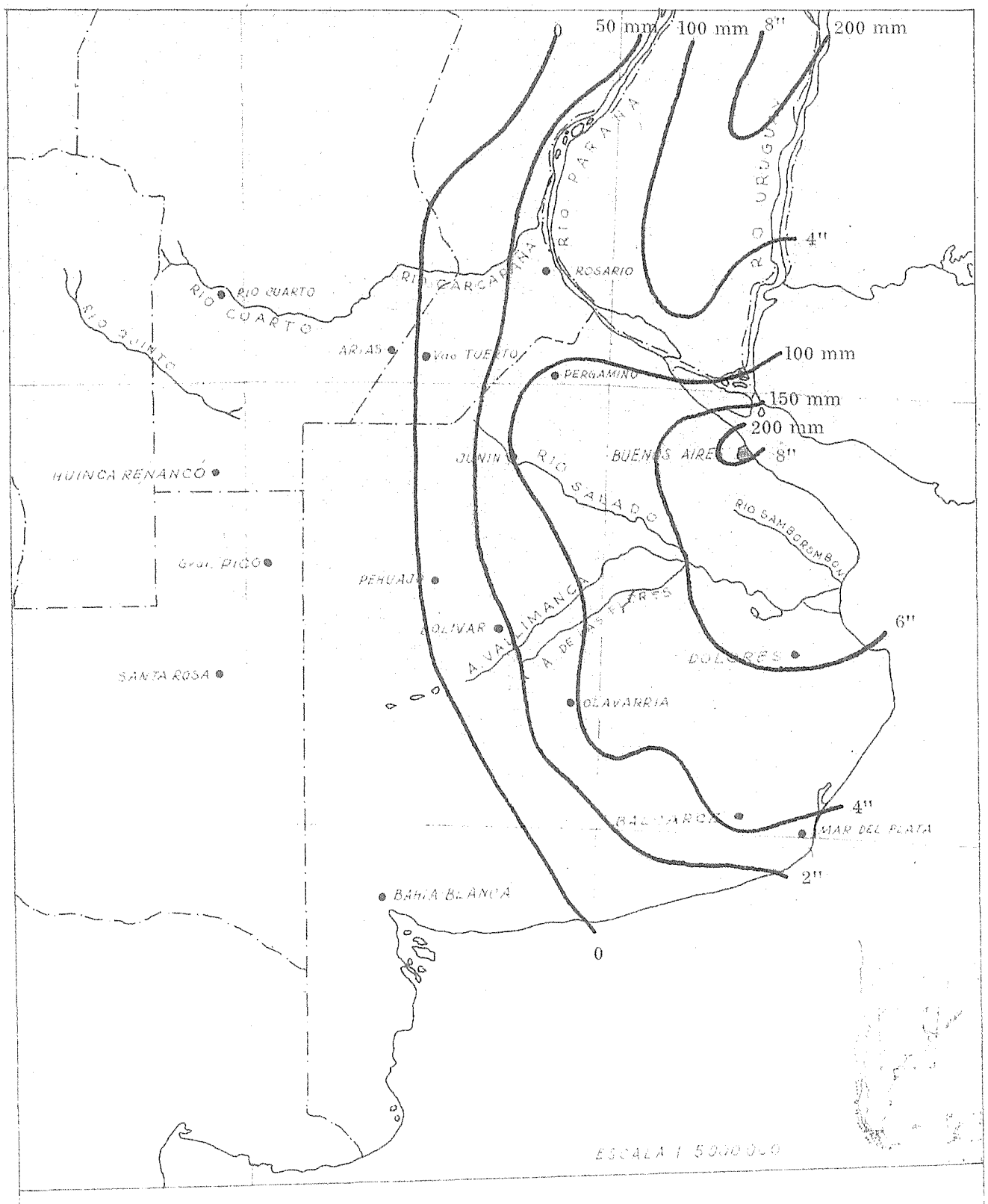
TEMPERATURAS MEDIAS DE JULIO

AVERAGE JULY TEMPERATURE



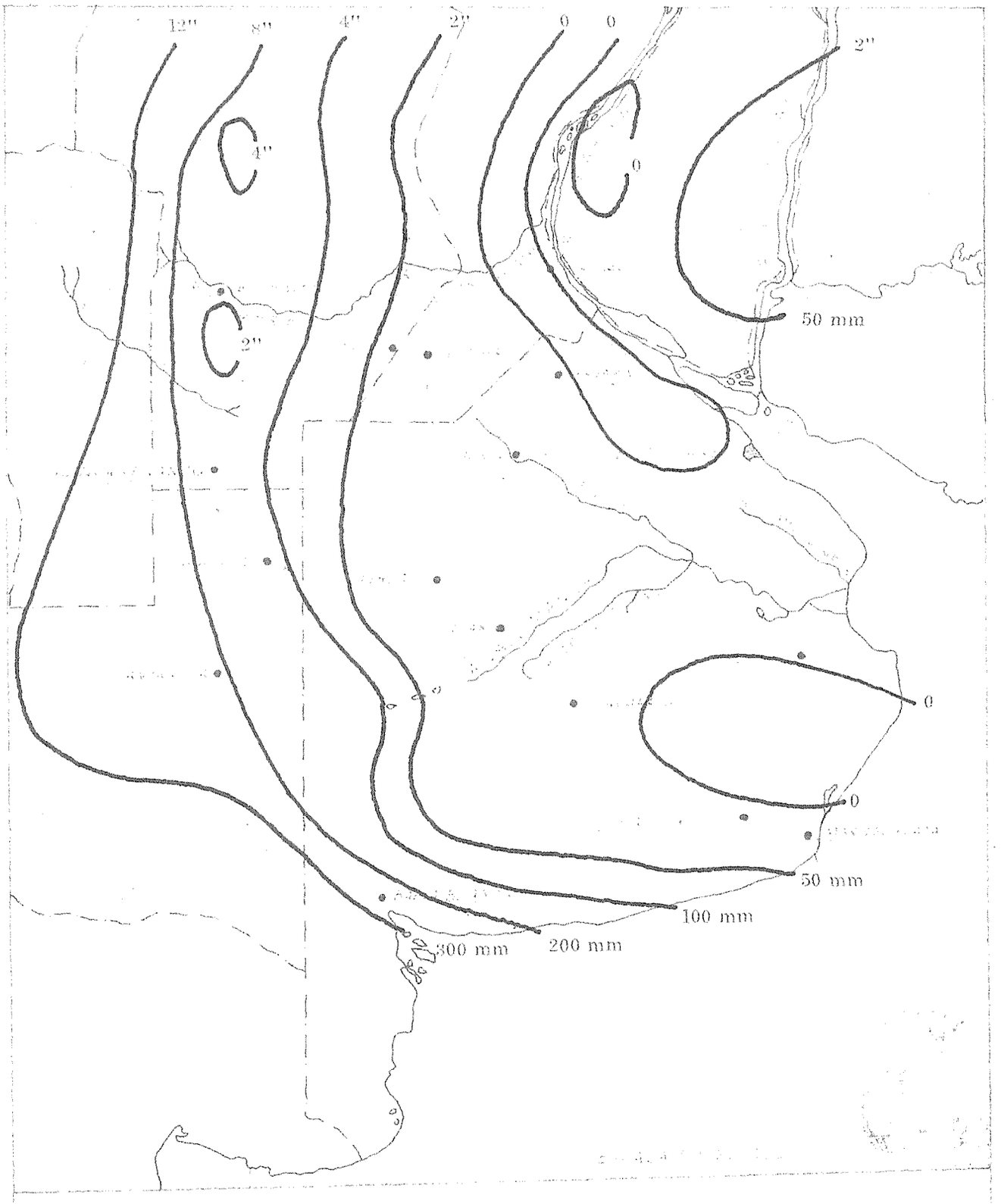
EVAPOTRANSPIRACION REAL ANUAL

REAL ANNUAL EVAPOTRANSPIRATION



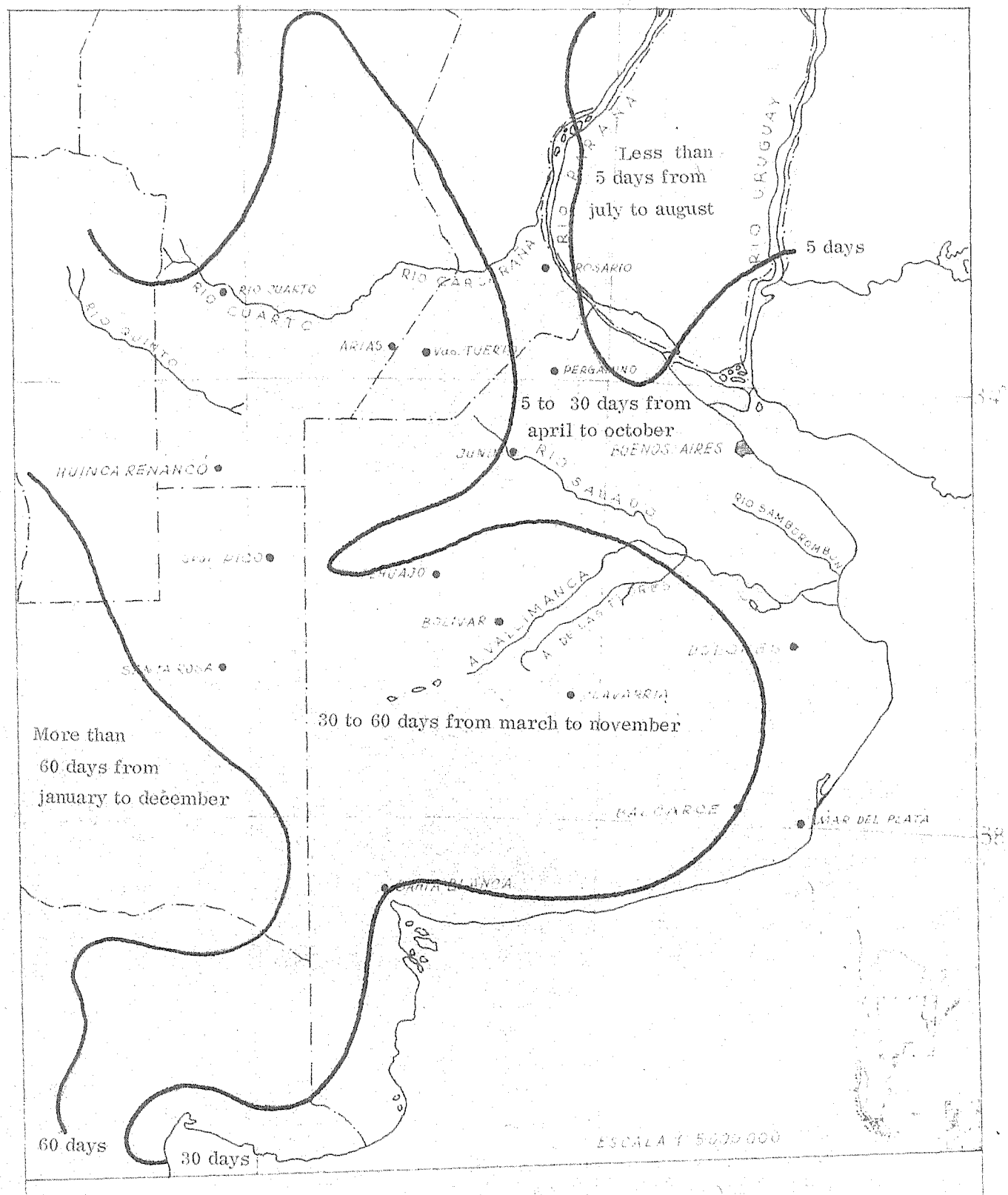
PROMEDIO ANUAL DEL EXCESO DE AGUA

MEAN ANNUAL EXCESS OF PRECIPITATION
OVER EVAPOTRANSPIRATION



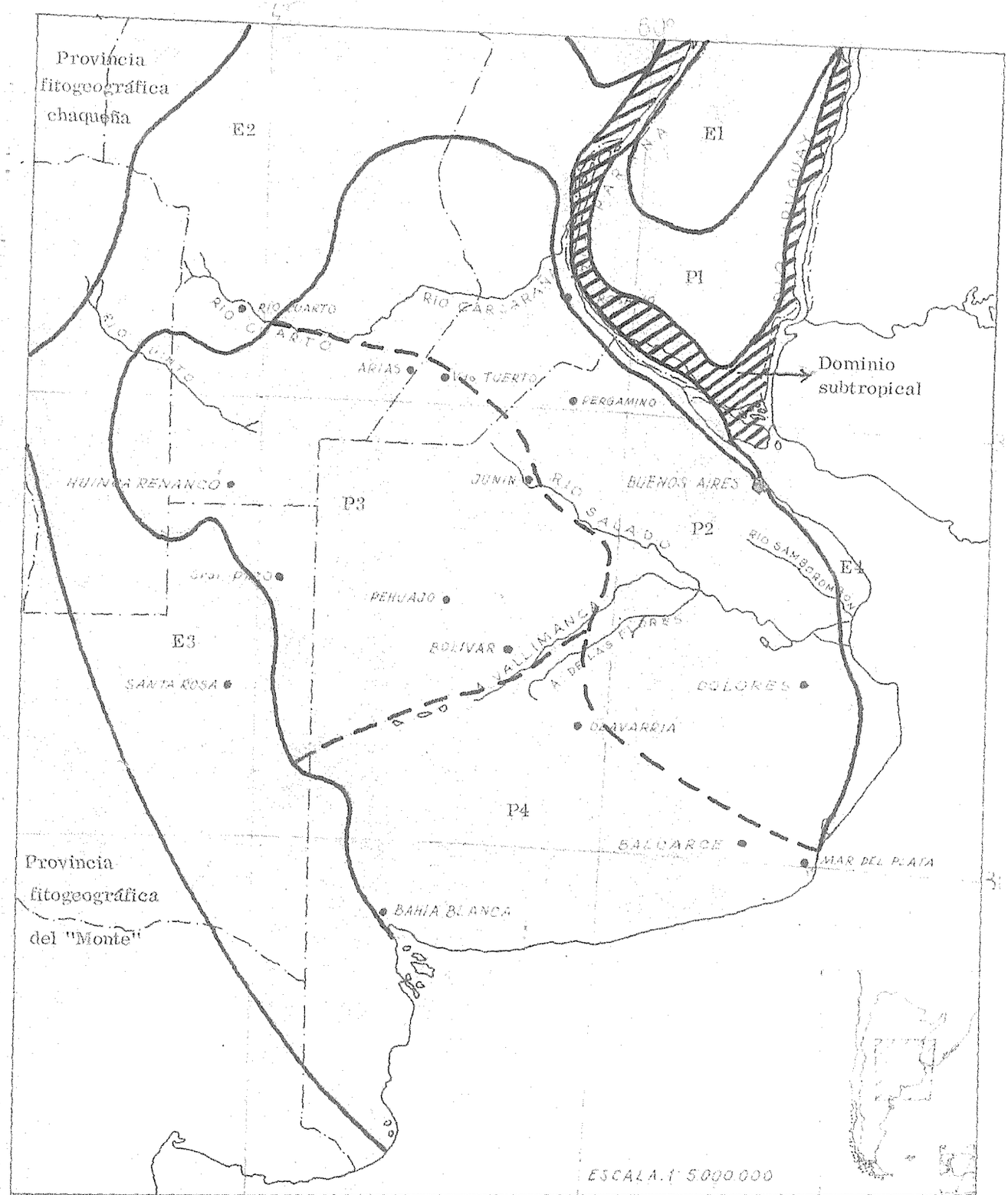
PROMEDIO ANUAL DE DEFICIENCIA DE AGUA

MEAN ANNUAL DEFICIT OF PRECIPITATION



FRECUENCIA MEDIA ANUAL DE HELADAS

MEAN ANNUAL FREQUENCY OF FROSTS IN DAYS



TERRITORIOS FITOGEOGRAFICOS DE LA REGION PAMPEANA

PHYTOGEOGRAPHIC REGIONS OF THE PAMPA (from A. L. Cabrera)

Phyto-province of the "Espinal"

E1: Ñandubay district

E2 : Algarrobo district

E3: Caldén district

E4: Tala district

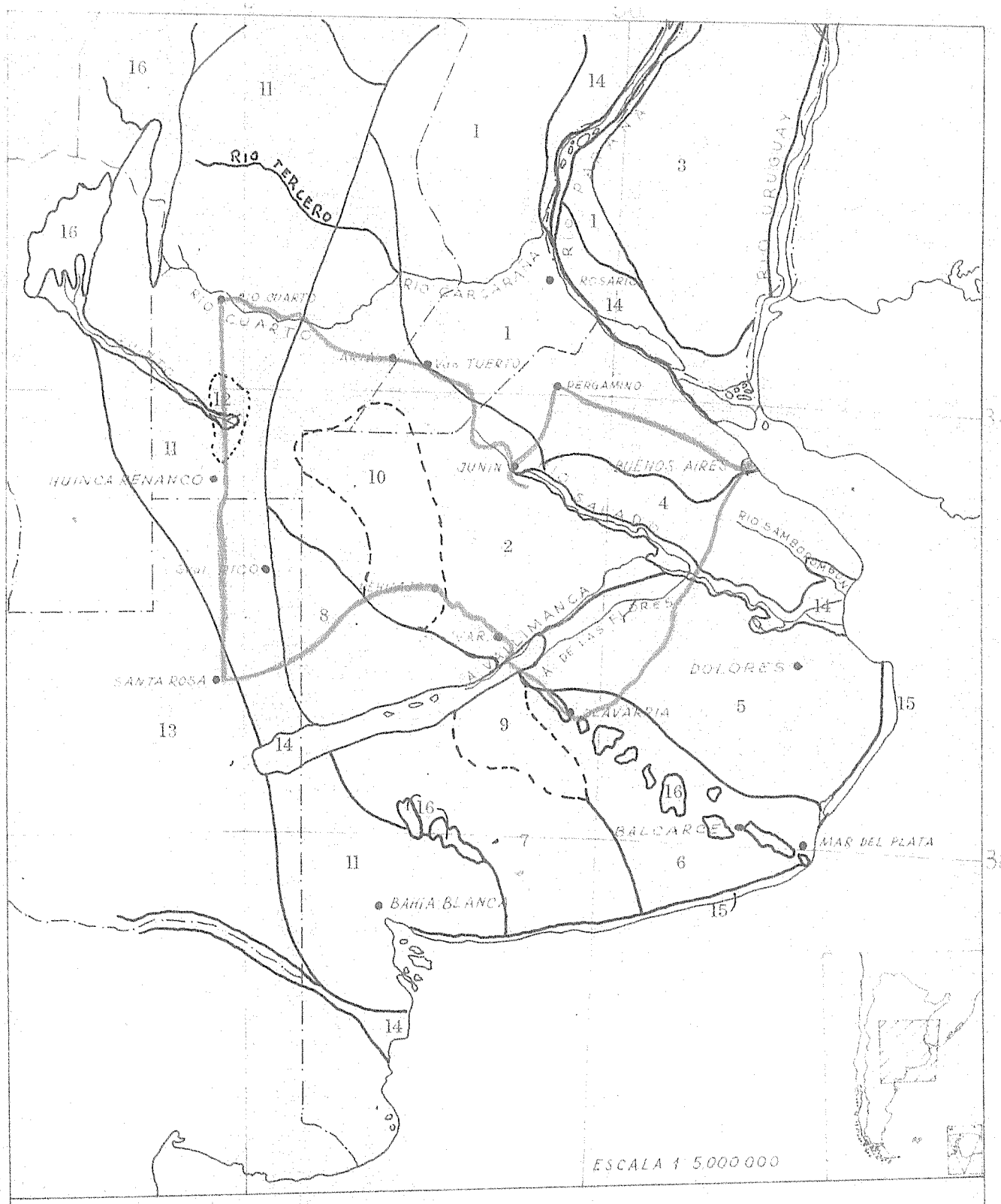
Phyto-province "pampeana"

P1 : Uruguayense district

P2: Eastern pampa district

P3: Western pampa district

P4: Southern pampa distric



MAPA DE GRANDES GRUPOS DOMINANTES DE SUELOS

MAP OF DOMINANT GREAT SOIL GROUPS OF THE PAMPEAN REGION

(Referencias en el texto)

(see legend in the text)

: itinerario del viaje (field tour)

minerals like volcanic glass, plagioclase, hornblende and pyroxenes . The bulk composition of these materials, uniform over considerable areas, suggest a substantial contribution from volcanic sources.

CLIMATE.- In the eastern part the climate is of the temperate sub-humid steppe regime without pronounced dry spells. Towards the west rainfall decreases gradually, making up for a semi-arid climate in the western part of the pampa.

Annual precipitation (see also maps) oscillates between 600 and 1000 mm, increasing in the direction from southwest to northeast. Peaks in precipitation are observed in spring and autumn, but no season is particularly rainy nor dry. The annual average moisture deficit ranges from 0 to 400 mm in the area, as indicated in the accompanying map.

Mean annual temperatures increase slightly from south to north (14°C in the southern pampa, 18°C in the northern part). In the littoral area seasonal variations are less marked than in the interior. Average daily oscillations of about 10 degrees C are observed in the east and about 15° in the west.

Snowfall is exceptional in the pampean region and the soil is never covered with snow at any time . Frost-free periods oscillate between 200 to 300 days on the average.

NATURAL VEGETATION.- The original natural vegetation in practically the whole region has been altered by the action of man. However, two phytogeographical provinces may still may be recognized: the "pampean" (grass) province and the "espinal" (thorny bush) province (see also map of phytogeographic regions).

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The grass province is dominated by species from the genus Stipa, associated with other gramineous species depending on climatic and soil conditions.

The thorny bush province is dominated by xerophilous leguminous species of the genus Prosopis, associated with other thorny species.

The grass province and its sub-regions forms the richest part of the pampean region; the thorny bushes appear in an arc around the grass steppe where semi-arid conditions prevail.

PREDOMINANT SOILS (prepared by P.H. Etchevehere and P.L.Arens)

In a number of soil studies and soil maps published by the Soils Institute of the INTA the following dominant great soil groups have been recognized. The distribution of these soil groups is shown in map N° 10. The figures on the map refer to the groups as described below.

1 - Brunizem soils with strongly developed B2t horizon (Argiudolls), on pampean loess materials. Main area of corn and wheat production, livestock raising.

2 - Brunizems without textural B, or with a weakly developed B2t horizon (Hapludolls), on fine sandy pampean loess materials. Livestock raising in the southern part, wheat and corn in the northern part.

3 - Grumusols and Brunizems with B2t horizon and intergrades. Area of wheat, linseed, and livestock production.

4 - Planosolic Brunizems, Planosols and Hydromorphic soils with or without fragipan.(Argialbolls, Argiaquolls, Fragaqualfs, etc.).Dairy farming and livestock fattening area.

5 - Humic and Low humic Gley soils with or without petrocalcic horizon ("tosca"), associated with hydromorphic alkali soils (Argiaquolls, Argialbolls, Duraquolls, Natralbolls, Natraquolls). Area of livestock fattening.

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6 - Brunizems with well developed B2t horizon and petrocalcic horizon (Lithic Argiudolls, Typic Argiudolls, Petrocalcic Argiudolls, Rendolls, Durudolls, etc.). Area of diversified agriculture and livestock production.

7 - Brunizems without or with a weakly developed B2t horizon and with a petrocalcic horizon (Petrocalcic Hapludolls). Southern wheat and livestock production region.

8 - Regosolic Brunizem and Regosols, mostly on sandy materials (Entic Haplustolls, Typic Haplustolls, Psammustents, Orthopsamments). Dry-farming area.

9 - Hydromorphic Brunizems with petrocalcic horizon and associated alkali soils (Duriaquolls, Calciaquolls, Natraquolls, etc.).

10 - Brunizems with B2t horizon and Bisequa of Regosolic Brunizem over Brunizem with B2t. Associated with Planosols with or without fragipan, and Planosolic Brunizem. (Bisequum of Hapludoll on Argiudoll or Argiaquoll; Fragiaquolls, Calcic Argiaquolls, Calciaquolls, Natric Argiaquolls, etc.). Livestock farming.

11 - Chestnut and Regosolic Chestnut, with or without petrocalcic horizon. (Typic, Entic or Petrocalcic Haplustolls) Dry farming area.

12 - Hydromorphic Chestnut soils and associated soils (Typic Haplaquolls, Duric and Psammentic Haplaquolls, Aquic Haplustolls).

13 - Calcic Brown and Regosolic Brown soils, with or without petrocalcic horizon (Typic Calciustolls, Petrocalcic Calciustolls, Cumulic, Aridic and Petrocalcic Haplustols , Calciorthids, etc.)

14 - Alluvial soils, associated with saline, alkaline and hydromorphic soils.

15 - Regosols and coastal sand dunes.

16 - Lithosols of pampean sierras and rock outcrops.

PRINCIPAL CROPS (prepared by J.C. Musto)

The high natural fertility and the easy workability of the pampean soils, combined with prevailing excellent climatic conditions and a natural vegetation consisting of grasses, have favoured a rapid expansion of livestock farming and cropping of cereals in the whole area.

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The agricultural development of the pampean region started in the last decade of the past century and was based principally in wheat and corn cropping. Other cereals and linseed were of secondary importance.

In the attached maps the principal regions are represented where each one of the important crops of the pampean region is grown. Some data on average yields in the various zones are included.

1.- Corn

The traditional Argentine corn belt includes the north of Buenos Aires, the south of Santa Fé and the east of Córdoba provinces. This area is characterized by favorable conditions for this crop owing to its soil and climate and its easy access to export markets.

The total area sown in corn fluctuates around 3.500.000 ha. Actually about 70 to 80% of the sowings are done with hybrid corn of the flint type.

2.- Wheat

The Argentine wheat region is considered as one of the best in the world and annual sowings cover an area of about 7.000.000 ha in the provinces of Buenos Aires, Santa Fé, Entre Ríos, Córdoba and La Pampa.

The province of Buenos Aires occupies the first place with about 2.500.000 ha sown and an annual production of about 2.600.000 tons.

Predominant varieties are of the "durum" type(hard and semi-hard winter wheat) soft wheat varieties are sown on a limited scale.

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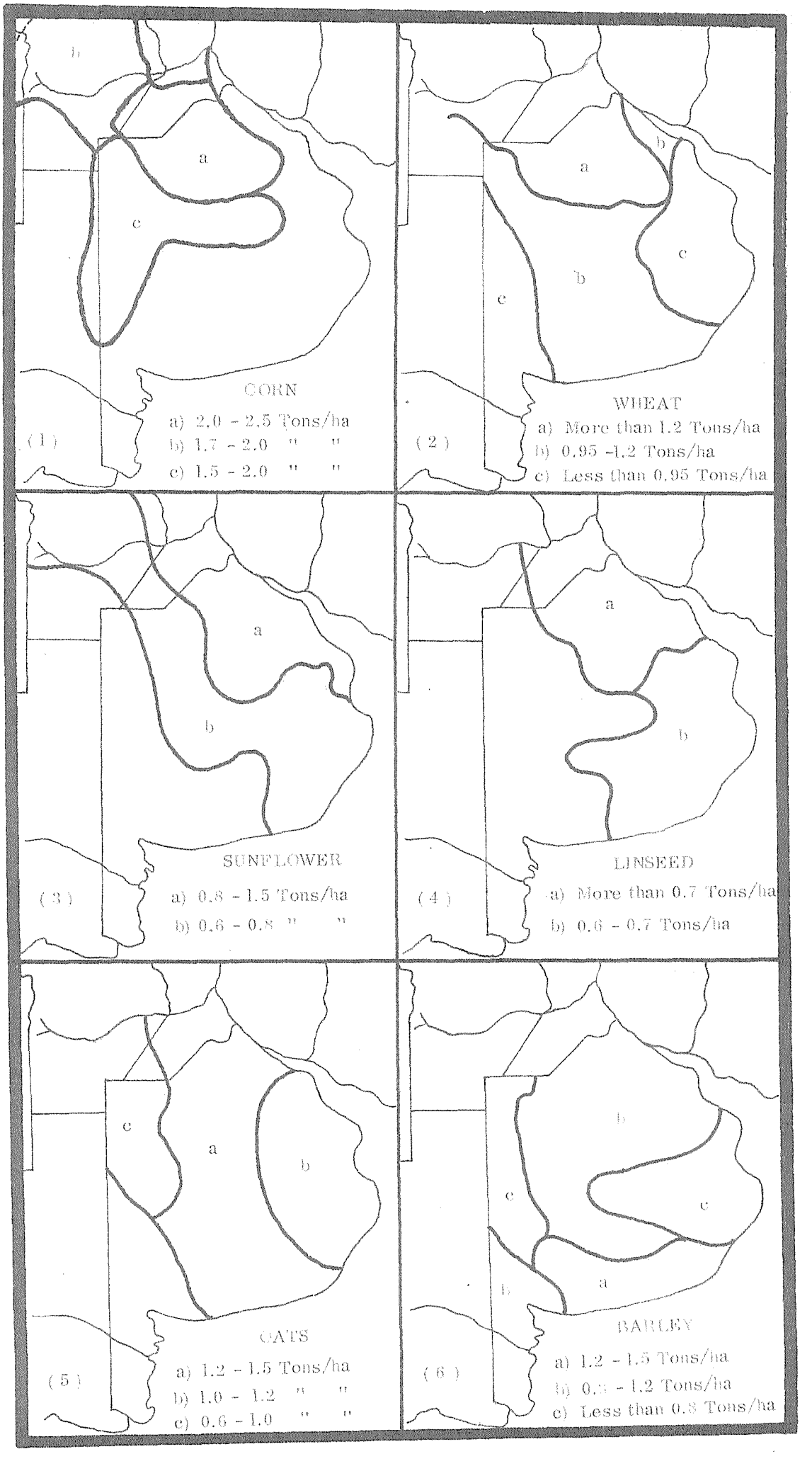
b
a
c
CORN
a) 2.0 - 2.5 Tons/ha
b) 1.7 - 2.0 " "
c) 1.5 - 2.0 " "
(1)
b
a
c
b
c
WHEAT
a) More than 1.2 Tons/ha
b) 0.95 -1.2 Tons/ha
c) Less than 0.95 Tons/ha
(2)
a
b
SUNFLOWER
a) 0.8 - 1.5 Tons/ha
b) 0.6 - 0.8 " "
(3)
a
b
LINSEED
a) More than 0.7 Tons/ha
b) 0.6 - 0.7 Tons/ha
(4)
c
a
b
OATS
a) 1.2 - 1.5 Tons/ha
b) 1.0 - 1.2 " "
c) 0.6 - 1.0 " "
(5)
b
c
c
a
b
BARLEY
a) 1.2 - 1.5 Tons/ha
b) 0.8 - 1.2 Tons/ha
c) Less than 0.8 Tons/ha
(6)

3.- Sunflower

This rather dispersed crop covers about 1.100.000 ha in Argentina, of which about 75% is grown in the pampean region.

Early sowings yield highest, as a consequence of better preparation of the soil and ample availability of soil moisture. The average yield of early sowings is between 0.8 and 2.0 tons per ha.

Late sowings (following wheat) yield less as these depend on irregular summer rainfall.

4.- Linseed

Total area sown in linseed fluctuates around 1.100.000 ha and average yields amount to 600 - 800 kg per ha.

Flax is sown to a much lesser extent; it yields 3.000 to 4.000 of fiber per ha.

5, 6 and 7.- Forrage cereals (Oats, barley and rye).

The province of Buenos Aires, south of Santa Fé and the eastern part of La Pampa constitute the principal area where these winter forrages are grown. About half of the area sown in oats and about all the area sown in barley and rye are destined as forrage.

Brewing barley is mainly grown in the southern part of Buenos Aires province. Recently the growing of grain and forrage sorghum has been extended considerably.

8.- Alfalfa

This is the most important forrage crop of the

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pampean region. Total area sown to alfalfa in Argentina is estimated at 8.000.000 ha., solely or in association with grasses.

Average duration and yield of alfalfa varies widely according to soil and climatic conditions, as well as management conditions.

9.- Potatoes

Potatoes can be cropped in nearly the whole of the pampean region, but for economic and ecological reasons it is limited to three principal zones: 1) South-Eastern part of Buenos Aires province. 2) The zone of Rosario. 3) The western zone of Buenos Aires province.

The total area sown in potatoes fluctuates around 250.000 ha. In general this crop is grown in rotation with alfalfa or pasture lands in zones 1 and 3; in the Rosario zone rotation is not a common practice.

10.- Natural grasslands and pasture.

The pampean region is the zone with the best natural grasslands of the whole of Argentina. Natural associations include Lolium multiflorum; Bromus unioloides; Medicago híspida; Medicago arábica; Paspalum dilatatum, etc, as well as many species of the genus Stipa.

Toward the west the quality of the natural pasture lands decreases owing to diminishing rainfall.

Sown pastures occuring in the region of over 700 mm rainfall are based on alfalfa, clovers and grasses(Medicago sativa, Melilotus albus and officinalis, Trifolium pratense, Trifolium repens, Dactylis glomerata, Festuca, Falaris arundinacea, Falaris bulbosa, Agropyron alongatum, etc.).

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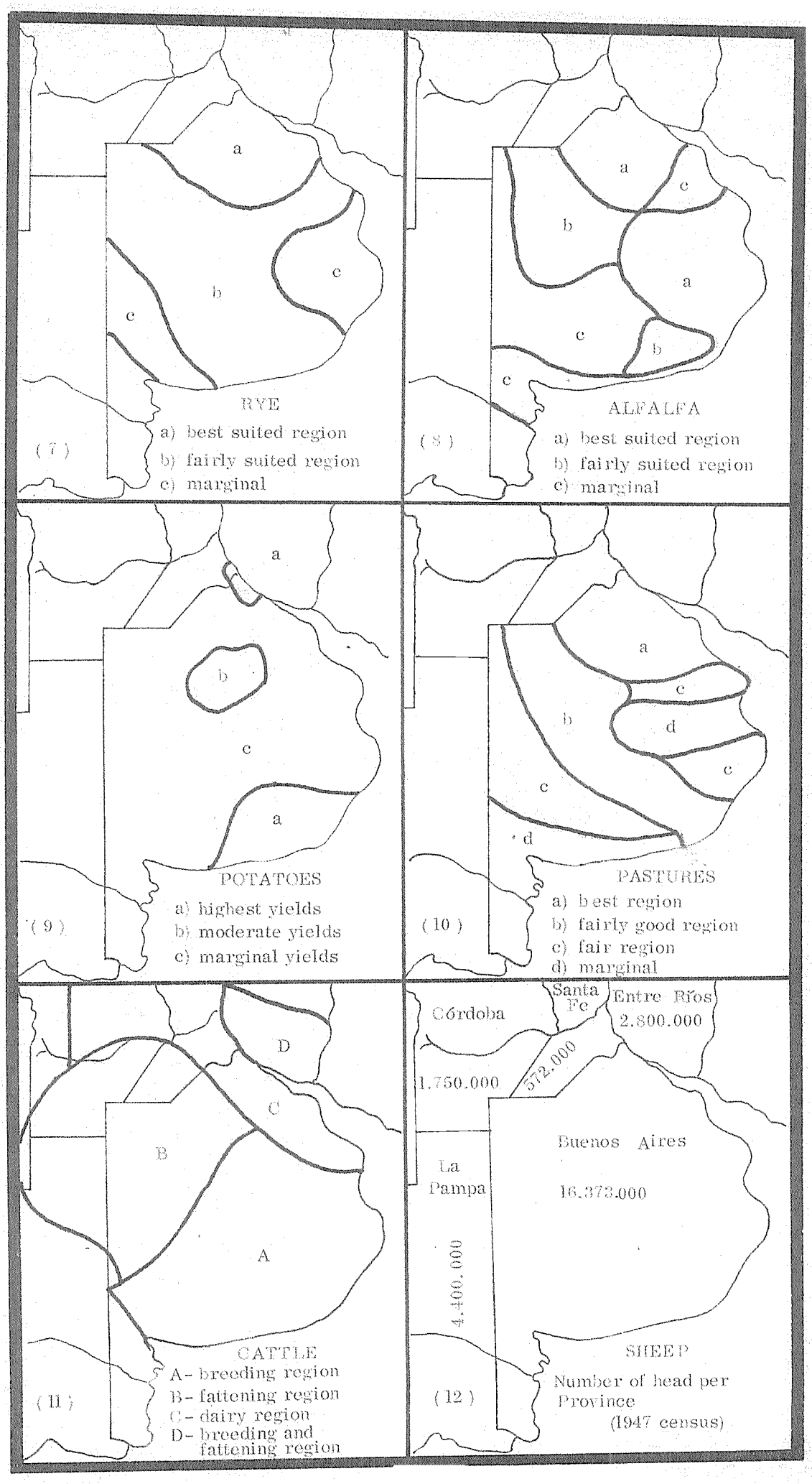
a
b
c
c
RYE
a) best suited region
b) fairly suited region
c) marginal
(7)
a
c
b
a
c
b
c
ALFALFA
a) best suited region
b) fairly suited region
c) marginal
(8)
a
b
c
a
POTATOES
a) highest yields
b) moderate yields
c) marginal yields
(9)
a
c
b
d
c
c
d
PASTURES
a) best region
b) fairly good region
c) fair region
d) marginal
(10)
D
C
B
A
CATTLE
A- breeding region
B- fattening region
C- dairy region
D- breeding and fattening region
(11)
Córdoba
Santa Fe
Entre Ríos
2.800.000
572.000
1.750.000
Buenos Aires
16.373.000
La Pampa
4.400.000
SHEEP
Number of head per Province
(1947 census)
(12)

In the semiarid and sub-humid pampean region (with less than 700 mm rainfall per year) artificial pastures include the following species: Medicago sativa;Melilotus albus and officinalis; Agropyron elongatum and cristatum; Bromus unioloides; Bromus brevis; Festuca arundinacea; Chloris Gayana, Eragrostis curvula; Phalaris tuberosa; Sorghum almun, etc., etc.

It is estimated that the pampean region includes about 40.000.000 ha of pasture lands, of which actually about 1.000.000 ha are sown in grasslands and 8.000.000 ha in alfalfares and forrages.

LIVESTOCK MANAGEMENT FORMS

11.- Cattle

About one third of the whole territory of the Republic of Argentine is suited for breeding of cattle of the improved breeds.

In the pampean region all cattle are pure breed or highly improved breed.

Region A: In this region Shorthorn, Hereford and Aberdeen Angus are breeded.

Region B: This is a fattening region for the same cattle.

Region C: Dairy region with Holando-Argentino and dairy Shorthorn.

Region D: This region is destined to breeding and fattening of Shorthorn, Hereford and Aberdeen Angus.

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SOIL PROFILE DESCRIPTIONS

Note : The tentative classifications have been done before the analytical results were known, thus they are given in the annex.

In the cases where the data do not belong to the described profile, it is expressly indicated.

Pedro H. Etchevehere

Juan C. Musto

SITE 1 - (34°19' S - 59°17' W) Profile "Solís Series"

Location: 4 km SE of Solís, province of Buenos Aires. Elevation: 36 m.

Climatic data: Buenos Aires Central Observatory.

	J	F	M	A	M	J	J	A	S	O	N	D	An.
T°C	23.3	22.5	20.5	16.7	12.9	10.3	9.9	11.2	13.4	15.7	19.1	21.8	16.4
Pp mm	86	84	110	108	78	56	51	68	86	70	101	97	995
Pot. Evap. mm	133	106	92	58	36	22	22	29	42	63	90	121	814

Soil profile description:

Ap 0-19 cm. Very dark gray (10YR 3/1 moist) silt loam; fine subangular blocky structure breaking to granular; friable; few roots; abrupt, smooth boundary.

A12 19-32 cm. Black (10YR 2/1 moist) silt loam; medium subangular blocky structure breaking to fine granular; friable; few roots, cracks; clear, smooth boundary.

B21 32-67 cm. Very dark brown (10YR 2/2 moist) silty clay; strong coarse and medium prismatic structure; friable very plastic, sticky; large amount of clay skins, few roots, few slickensides; gradual, wavy boundary.

B22 67-92 cm. Dark brown (7.5YR 3/2 moist) heavy clay; strong, coarse to medium prismatic structure; friable, very sticky, very plastic; large amount of clay skins; few roots; few slickensides; gradual, wavy boundary.

B23 92-120 cm. Brown to dark brown (7.5YR 4/2 moist) Silty clay; strong coarse and medium prismatic structure; friable; very sticky; very plastic, abundant clay skins; few slickensides; clear, wavy boundary.

B31 120-145 cm. Brown to dark brown (7.5YR 4/3 moist) silty clay loam; weak, medium prismatic structure; friable; very plastic; sticky; few clay skins; abrupt, wavy boundary.

B32 145-190 cm. Brown to dark brown (7.5YR 4/4 moist) silty clay loam; weak, medium prismatic structure; friable, many lime concretions; few clay skins; diffuse boundary.

Cca 190 + cm. Brown (7.5YR 5/4 moist) silty clay loam; massive; loose; many lime concretions.

Soil classification (tentative)

Argentine map: Brunizem máximo(con fuerte B2t.)

7th. Approximation: Vertic Argiudoll ?

F.A.O. system :

Notes :

SITE 2 - (33°58' S - 60°35' W) Profile "Pergamino Series"

Location: Pergamino Agricultural Experiment Station

Elevation: 68 m.

Climatic data:

	J	F	M	A	M	J	J	A	S	O	N	D	An.
T°C	23.8	22.9	20.3	16.5	12.7	9.7	9.7	10.8	13.5	16.2	19.5	22.2	16.5
Pp mm	106	92	109	102	66	34	37	45	62	82	105	113	953
Pot. Evap. mm	137	109	91	56	35	20	22	27	43	66	93	124	823

Soil profile description:

Ap 0-18 cm. Very dark gray (10YR 3/1 moist) silty loam; weak, fine granular structure; very friable; many roots; abrupt boundary.

A12 18-28 cm. Black to very dark gray (10YR 2.5/1 moist) silty loam; medium subangular blocky structure to granular; friable; many roots; clear boundary.

B1 28-38 cm. Dark brown (10YR 3/3 moist) silty clay loam; medium subangular blocky structure; slightly sticky; slightly plastic; slightly hard; many roots; clear boundary.

B21 38-68 cm. Brown to dark brown (7.5YR 4/2 moist) silty clay; strong medium prismatic structure breaking to medium angular blocky structure; very plastic; sticky very hard; abundant dark brown (7.5YR 3/2 moist) clay skins; few roots; clear boundary.

B22 68-113 cm. Brown to dark brown (7.5YR 4/4 moist) silty clay loam to clay loam; medium prismatic breaking to medium angular blocky structure; very plastic; very sticky; very hard; abundant dark brown (7.5YR 4/2, moist) clay skins; gradual boundary.

B3 113-150 cm. Brown (7.5YR 4.5/4 moist) silty clay loam; medium subangular blocky structure; slightly sticky; slightly plastic; slighty hard, few clay skins; diffuse boundary.

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SITE 5 - (34°27' S - 61°02' W) Profile "Saforcada Series"

Location: 4 km E of Agustina (Buenos Aires Province) Elevation: 88 m.

Soil profile description:

A11 0-21 cm. Very dark brown (10YR 2/2 moist)loamy sand; weak subangular blocky to granular structure breaking to single grain; very friable; nonplastic; nonsticky; common roots; clear, wavy boundary.

A12 21-35 cm. Very dark grayish brown (10YR 3/2 moist) loamy sand; weak, subangular blocky structure breaking to single grain; very friable; nonplastic; nonsticky; common roots; gradual boundary.

AC1 35-50 cm. Dark yellowish brown (10YR 3/4 moist)loamy sand; weak, medium subangular blocky structure; loose; nonplastic;nonsticky; common roots; diffuse boundary.

AC2 50-90 cm. Dark brown (7.5YR 3/2 moist) loamy sand; weak, coarse subangular blocky structure; loose, nonplastic; nonsticky; few roots; diffuse boundary.

C1 90-130 cm. Dark yellowish brown (10YR 3/4 moist)sand; massive to single grain; loose; nonplastic; nonsticky; few roots; diffuse, smooth boundary.

C2 130 + cm. Dark yellowish brown (10YR 3/4 moist) sand; single grain; loose; nonplastic; nonsticky.

Soil classification (tentative)

Argentine map: Brunizem mínimo (regosólico)

7th. Approximation: Entic Hapludoll

F.A.O. system:

Notes :

SITE 6 - (34°15' S - 61°30' W) Profile "Merceditas Series"

Location: 20 km WNW of Gral.Arenales, Elevation: 90 m.
provincia of Buenos Aires.

Climatic data:

T°C
Pp mm
Pot.
Evap.
mm

Soil profile description:

Ap 0-17 cm. Very dark brown (10YR 2/2 moist) sandy loam; weak, fine granular structure; soft; friable; many roots; abrupt, smooth boundary.

A12 17-28 cm. Very dark grayish brown (10YR 3/2 moist); loam to sandy loam; strong, medium angular blocky structure; hard, friable; many roots; plow sole;clear, smooth boundary.

B2 28-53 cm. Dark brown (7.5YR 3/2 moist) loam [illegible] moderate, medium to coarse angular blocky structure; soft; friable; few clay skins; patches of organic matter; biological activity; gradual,smooth boundary.

B3 53-90 cm. Brown to dark brown (7.5YR 3.5/2 moist) loam to sandy loam; weak, medium subangular blocky structure; soft; friable; common roots; difuse,smooth boundary.

C 90 + cm. Brown to dark brown (7.5YR 4/2 moist) sandy loam; single grain; loose; few roots.

Soil classification (tentative)

Argentine map: Brunizem mínimo (con B2t incipiente)

7th. Approximation: Typic Hapludoll (with cambic horizon)

F.A.O. system :

Notes: Ratio % clay B/% clay A=1.17

SITE 7 - (33°49' S - 61°54' W) Profile "Venado Tuerto Series"

Location: 9 km SE of Venado Tuerto, province of Santa Fe

Elevation: 105 m.

Soil profile description:

Ap 0-16 cm. Very dark brown (10YR 2/2 moist) loam; moderate, medium granular structure; friable, slightly plastic; nonsticky; many roots; abrupt, smooth boundary.

A12 16-32 cm. Very dark brown (10YR 2/2 moist) loam; medium, angular blocky structure breaking to granular; friable; slightly plastic; nonsticky; many roots; coleoptera; clear; smooth boundary.

B1 32-40 cm. very dark grayish brown (10YR 3/2 moist) loam; moderate, medium subangular blocky structure; friable; plastic; slightly sticky; few clay skins; common roots; coleoptera; abrupt, smooth boundary.

B2 40-60 cm. Very dark grayish brown (10YR 3/2 moist) loam, brown to dark brown (10YR 4/3) when dry; moderate, medium prismatic structure; slightly hard; friable; plastic; slightly sticky; few clay skins; few roots; patches of organic matter; gradual, smooth boundary.

B31 60-90 cm. Dark yellowish brown (10YR 3/4 moist) loam, brown (10YR 5/3) when dry; strong, coarse; medium subangular blocky structure; friable; slightly plastic; nonsticky; few roots; gradual, smooth boundary.

B32 90-120 cm. Dark yellowish brown (10YR 3/4 moist) sandy loam; weak, medium subangular blocky structure; friable; nonplastic; nonsticky; diffuse boundary.

C 120 + cm. Dark yellowish brown (10YR 3/4 moist) sandy loam; massive; loose; nonplastic; nonsticky.

Soil classification (tentative)

Argentine map: Brunizem medio (con B2t moderadamente bien desarrollado).

7th. Approximation: Typic Hapludoll?

F.A.O. system :

Notes : Ratio % clay B/% clay A= 1.17 (Cambic horizon) or 1.0

SITE 8 - (33°35' S - 62°50' W) Profile " Canals"

Location : 8 km E of Canals (Córdoba province) Elevation: 122 m.

Climatic data :(for Arias, 40 km E from the site)

	J	F	M	A	M	J	J	A	S	O	N	D	An.
T°C	243	234	209	169	130	94	92	107	137	162	196	225	166
Pp mm	95	91	95	79	40	17	29	24	54	77	93	107	801
Pot. Evap. mm	142	113	94	58	35	18	19	26	43	66	94	126	834

Soil profile description:

A1 0-20 cm. Very dark grayish brown (10YR 3/2 moist) loamy sand; medium, subangular blocky structure breaking to fine granular; very friable; nonplastic; nonsticky; many roots; gradual, smooth boundary.

AC 20-40 cm. Dark brown (10YR 3/3 moist) fine sand; very weak, coarse subangular blocky structure breaking to single grain; very friable; nonplastic; nonsticky; many roots; diffuse boundary.

C 40+ cm. Brown to dark brown (10YR 4/3 moist) fine sand, brown (10YR 5/3) when dry; single grain; loose; nonplastic; nonsticky; common roots.

Soil classification (tentative)

Argentine map: Brunizem regosólico intergrado a Castaño.

7th. Approximation: Entic Hapludoll

F.A.O. system :

Notes :

SITE 9 - (33°14' S - 63°35' W) Profile "Agua Dulce"

Location: Estancia "Los Toros" near Agua Dulce (Córdoba province) Elevation: 198 m.

Climatic data: (for Río Cuarto, 70 km W from the site)

T°C	234	225	200	163	126	91	89	104	135	164	195	221	162
Pp mm	120	89	91	66	29	10	13	18	42	79	91	132	780
Pot. Evap. mm	134	107	89	56	35	18	19	27	44	68	94	123	814

Soil profile description:

Ap 0-12 cm. Very dark grayish brown to dark brown (10YR 3/2.5 moist) fine loamy sand; weak, fine granular structure; very friable; nonplastic; nonsticky; common roots; abrupt, smooth boundary.

A12 12-21 cm. Very dark grayish brown (10YR 3/2 moist) fine loamy sand; very weak, subangular blocky structure breaking to single grain; very friable; nonplastic; nonsticky; common roots; muscovite lamellae, gradual, smooth boundary.

AC 21-50 cm. Dark yellowish brown (10YR 3/4 moist) sand, dark yellowish brown (10YR 4/4) when dry; weak, subangular blocky structure; very friable; nonplastic; nonsticky; common roots; muscovite lamellae; diffuse, smooth boundary.

C1 50-160 cm. Dark yellowish brown (10YR 4/4 moist) sand; light yellowish brown to yellowish brown (10YR 5.5/4) when dry; massive to single grain; loose; muscovite lamellae; abrupt, wavy boundary.

C2ca 160 + cm. Loose sandy material, with free carbonates.

Soil classification (tentative)

Argentine map: Castaño (sin horizonte B)

7th. Approximation: Entic Hapludoll or Entic Haplustoll

F.A.O. system:

Notes :

SITE 10 (33°43' S - 64°26' W) Profile "Malena"

Location: 65 km S of . Río Cuarto, province of Córdoba. Elevation: 280 m.

Soil profile description:

A1 0-27 cm. Very dark gray brown (10YR 3/2 moist)loamy sand; weak fine granular structure; very friable; many roots; krotowines; gradual, smooth boundary.

AC 27-55 cm. Dark yellowish brown (10YR 3/4 moist)loamy sand; moderate, coarse subangular blocky structure; very friable;gypsum ; abundant krotowines; diffuse, smooth boundary.

C 55+ cm. Dark yellowish brown (10YR 4/4 moist)loamy sand to sand; massive to single grain; loose;abundant krotowines; gypsum.

Soil classification (tentative)

Argentine map: Castaño regosólico

7th. Approximation: Entic Haplustoll (or Typic Haplustoll?)

F.A.O. system:

Notes:

SITE 11 - (34°33' S - 64°23' W) Profile "Huinca Renancó"

Location: 32 km N of Huinca Renancó, province of Córdoba. Elevation: 200 m.

Climatic data: (for Huinca Renancó)

T°C	25.0	23.6	22.4	16.3	12.1	8.8	8.7	10.3	13.4	16.8	20.5	23.4	16.6
Pp mm	85	84	91	53	34	13	15	26	37	72	92	90	692
Pot. Evap. mm	150	115	91	54	31	16	17	24	42	69	101	135	845

Soil profile descrition :

A1 0-20 cm. Very dark gray brown (10YR 3/2 moist) sandy loam; weak fine subangular blocky structure breaking to single grain; very friable; diffuse, smooth boundary.

AC 20-45 cm. Very dark gray brown to dark brown (10YR 3/2.5 moist) sand; massive; loose; diffuse, wavy boundary.

C1 45-200 cm. Dark yellowish brown (10YR 3/4 moist) sand; massive to single grain; loose; abrupt wavy boundary.

C2ca 200 + cm. Dark yellowish brown (10YR 3/4 moist) sand; massive to single grain; loose; abundant free carbonates.

Soil classification (tentative)

Argentine map: Castaño regosólico

7th. Approximation: Entic Haplustoll

F.A.O. system:

Notes :

SITE 12 - (35°08' S - 64°22' W) Profile "Realicó"

Location: 10 km S of Realicó, province of La Pampa. Elevation: 167 m.

Soil profile description:

A1 0-30 cm. Very dark grayish brown (10YR 3/2 moist) sandy loam; weak fine granular; loose; nonplastic, nonsticky; krotowines; clear, smooth boundary.

AC 30-60 cm. Dark brown to dark yellowish brown (10YR 3/3.5 moist) loam; weak medium subangular blocky structure breaking to single grain; loose; few lime concretions; diffuse, wavy boundary.

Cca 60-105 cm . Dark yellowish brown (10YR 3/4 moist) sandy loam (to sandy clay loam?); massive to single grain; loose; common lime concretions; abrupt, smooth boundary.

IIRca 105 + cm. Indurated calcareous pan.

Soil classification (tentative)

Argentine map: Castaño regosólico (con tosca)

7th. Approximation: Haplic Durustoll (or Petrocalcic Haplustoll?)

F.A.O. system:

Notes :

SITE 13 - (36°15' S - 64°15' W) Profile "Winifreda"

Location: Near Winifreda, province of La Pampa.

Elevation: 160 m.

Soil profile description:

A1 0-17 cm. Very dark grayish brown (10YR 3/2 moist) with a upper part dark brown (10YR 3/3) loam; medium subangular blocky structure breakingto weak fine granular; loose; clear, smooth boundary.

AC 17-44 cm. Dark yellowish brown (10YR 3/4 moist) sandy loam; weak medium and coarse subangular blocky structure; loose; gradual smooth boundary.

C1 44-63 cm. Dark yellowish brown (10YR 3/4 moist)loam, brown (10YR 5/3) when dry; massive; loose; few lime concretions; abrupt, wavy boundary.

C2ca 63-100 cm. Dark yellowish brown (10YR 3/4 moist) silty loam , yellowish brown (10YR 5/4) when dry; massive; loose; common lime concretions; abrupt, wavy boundary.

IIRca
(IIOca) 100+ cm. Indurated calcareous pan.

Soil classification (tentative)

Argentine map: Castaño intergrado a Pardo (con tosca)

7th. Approximation: Orthidic Durustoll (or Petrocalcic Haplustoll?)

F.A.O. system:

Notes:

SITE 14 - (36°27' S - 64°17' W) Profile "Santa Rosa"

Location: 18 km N of Santa Rosa, provincie of La Pampa. Elevation: 170 m.

Climatic data:

	J	F	M	A	M	J	J	A	S	O	N	D	An.
T°C	24.2	22.7	19.1	15.4	11.3	8.2	8.3	9.5	12.5	16.1	19.6	23.0	15.8
Pp mm	60	84	71	42	25	13	17	22	38	82	75	71	600
Pot. Evap. mm	145	110	84	52	29	16	17	23	39	68	99	136	818

Soil profile description:

A1 0-10 cm; Dark brown (10YR 3/3 moist) sandy loam;weak fine granular structure; very friable; nonplastic; nonsticky; clear, wavy boundary.

AC 10-20 cm. Dark yellowish brown (10YR 3/4 moist)sandy loam; very weak fine granular structure breaking to single grain; loose; few lime concretions; abrupt, wavy boundary.

C1ca 20-40 cm. Dark brown (10YR 3/3 moist) fine sandy loam, brown (10YR 4.5/3) when dry; single grain;loose; few lime concretions; diffuse lower boundary.

C2ca 40+ cm. Brown to dark brown (10YR 4/3 moist) fine sandy loam; massive to single grain; loose; few lime concretions.

Soil classification (tentative)

Argentine map: Pardo .

7th. Approximation: Typic Haploxeroll or Typic Haplustoll or Haplic Calciustoll or Mollic Calciorthid.

F.A.O. system:

Notes :

SITE 15 - (36°13' S - 63°4' W) Profile "Pellegrini Series"

Location: Bocayuva railway Station Elevation:107.5m.

Soil profile description:

A1 0-28 cm. Very dark gray brown (10YR 3/2 moist) loamy sand; weak fine granular structure; loose; nonplastic; nonsticky; abundant roots;krotowines; gradual, wavy boundary.

AC 28-60 cm. Brown to dark yellowish brown (10YR 4/3.5 moist) loamy sand; very weak medium subangular blocky structure breaking to massive; loose; non-plastic, nonsticky; gradual, wavy boundary.

C1 60-90 cm. Brown to dark brown (10YR 4/3 moist)sand; massive to single grain; loose; clear, wavy boundary.

C2ca 90+ cm. Brown (7.5YR 4.5/4 moist) sand; massive to single grain; loose; many lime concretions;few, faint,fine iron mottles.

Soil classification (tentative)

Argentine map: Brunizem regosólico (intergrado a Castaño?)

7th. Approximation: Entic Haplustoll or Entic Hapludoll.

F.A.O. system:

Notes: This soil series has normally no carbonates.

SITE 16 - (35°51' S - 62°34' W) Profile "Tejedor Series"

Location: 5 km W of Berutti, province of Buenos Aires. Elevation: 86 m.

Climatic data: (for Trenque Lauquen, 17 km SW from the site)

	J	F	M	A	M	J	J	A	S	O	N	D	An.
T°C	24.0	22.8	19.9	15.7	11.8	8.3	8.3	9.7	12.6	15.6	19.2	22.4	15.8
Pp mm	72	94	92	71	36	22	33	31	52	80	87	100	770
Pot. Evap. mm	143	109	89	54	32	16	17	24	40	63	92	128	807

Soil profile description:

A1 0-18 cm. Black (10YR 2/1 moist) loam; fine granular and subangular blocky structure; friable; with recent light gray (2.5Y 7/2 moist) volcanic ash; abrupt, wavy boundary.

A2 18-38 cm. Dark grayish brown (10YR 4/2 moist) sandy loam, gray (10YR 5.5/1) when dry; weak medium subangular blocky structure to massive; very friable; porous; abrupt, wavy boundary.

B2 38-62 cm. Dark brown (10YR 3/3 and 7.5YR 3/2 moist) sandy clay loam; coarse subangular blocky structure to massive; friable; few clay skins; common prominent reddish brown (5YR 4/4) mottles.

IIRCa
(Cca) 62+ cm. Strongly cemented duripan; very calcareous.

Soil classification (tentative)

Argentine map: Brunizem planosólico (con tosca)

7th. Approximation: Duraquollic Argialboll?

F.A.O. system:

Notes:

SITE 17 - (35°53' S - 61°44' W) Profile "Nueva Plata"

Location: 7 km ENE of Nueva Plata, province of Buenos Aires. Elevation: 87 m.

Soil profile description:

Ap 0-13 cm. Very dark brown (10YR 2/2 moist) loam; moderate fine granular; friable; slightly plastic; slightly sticky; abrupt, smooth boundary.

A12 13-32 cm. Very dark brown (10YR 2/2 moist) loam; medium subangular blocky structure breaking to moderate fine granular; friable; slightly plastic; slightly sticky; clear, smooth boundary.

AC 32-51 cm. Very dark gray brown (10YR 3/2 moist) sandy loam; weak medium subangular blocky structure; very friable; slightly plastic, nonsticky; krotowines; clear, smooth boundary.

A2b 51-64 cm. Dark brown (7.5YR 3.5/2 moist) loamy sand; massive to single grain; very friable; nonsticky; nonplastic; few, faint, fine iron mottles; abrupt, smooth boundary.

B2b 64-83 cm. Brown to dark brown (7.5YR 4/2 moist) clay loam; strong coarse prismatic structure; firm; hard; plastic; nonsticky; few lime concretions; common very dark grayish brown (10YR 3/2) and dark brown (7.5YR 3/2) clayskins; common faint, fine iron mottles; slightly cemented; gradual boundary.

B3b 83-125 cm. Brown (7.5YR 5/4 moist) sandy loam; moderate medium prismatic breaking to medium blocky structure; friable; nonplastic; slightly sticky; few, faint, fine iron mottles ; lime concretions; diffuse boundary.

Cb 125+ cm. Sand; massive to single grain; loose; few mottled; lime concretions.

Soil classification (tentative)

Argentine map: Brunizem regosólico sobre Planosol o Brunizem planosólico enterrado.

7th. Approximation: Typic Argialboll ?

F.A.O. system:

Notes:

SITE 18 - (36°52' S - 60°26' W) Profile "Cantera Olavarría"

Location: 10 km NW of Olavarría, province of Buenos Aires. Elevation: 182,5m.

Soil profile description:

A1	0-22 cm. Black (10YR 2/1 moist) sandy loam; weak fine granular; very friable; nonplastic; nonsticky; abrupt boundary
	lithological discontinuity indicated by a gravelly layer
IIC1ca	22 + cm. Cemented, coarse platy structure calcareous layer.
IIC2ca	Massive, silty clay (caolinitic) marl, with crystalline rock pebbles and angular cobbles included.
IIIC3	Weathering granitic rocks
IIIR	Granitic rock of the basement complex.

Soil classification (tentative)

Argentine map: Brunizem somero (sobre tosca)

7th. Approximation: Lithic Hapludoll

F.A.O. system:

Notes:

SITE 19a - (36°56' S - 60°17' W) Profile "Escuela de Agricultura a"

Location: 4 km SE of Olavarría, province of Buenos Aires. Elevation: 172 m.

Soil profile description:

A1 0-30 cm. Black to very dark brown (10YR 2/1.5 moist) loam; moderate medium granular structure; friable; slightly sticky, slightly plastic; krotowines; clear, smooth boundary.

B1 30-41 cm. Very dark brown (10YR 2/2 moist) clay loam; moderate medium subangular blocky structure; friable; slightly plastic; nonsticky; abrupt, smooth boundary.

B2t 41-63 cm. Dark yellowish brown (10YR 3/4 moist) clay; moderate medium prismatic breaking to moderate medium blocky structure; friable; plastic; sticky; many, very dark gray brown (10YR 3/2) clay skins; gradual boundary.

B3 63-115 cm. Dark yellowish brown (10YR 4/4 moist) sandy loam; medium subangular blocky structure to massive; very friable; slightly plastic ; non-sticky; few clay skins; abrupt, wavy boundary.

IIRca(IICca) 115+ cm. Pinkish gray (7.5YR 7/2 moist) strongly cemented calcareous pan; coarse platy structure; stratified petrocalcic horizon.

Soil classification (tentative)

Argentine map: Brunizem máximo (con B2t bien desarrollado) con tosca.

7th. Approximation: Petrocalcic Argiudoll? or Typic Argiudoll.

F.A.O. system:

Notes:

SITE 19b - (36°56' S - 60°17' W) Profile "Escuela de Agricultura b"

Location: 4 km SE of Olavarría, province of Buenos Aires. Elevation: 170 m

Soil profile description:

A1 0-15 cm. Black to very dark brown (10YR 2/1.5 moist) loam; weak fine granular structure; friable, slightly plastic, nonsticky; lime gravels; clear, smooth boundary.

B2t 15-24 cm. Very dark brown (10YR 2/2 moist) clay loam; fine prismatic structure; friable, slightly plastic, slightly sticky; lime gravels; common clayskins; abrupt, smooth boundary.

IIRCa(IICca) 24+ cm. Strongly cemented calcareous material; platy structure; lime and granitic gravels.

Soil classification (tentative)

Argentine map: Brunizem somero con Bt (sobre tosca); rendsinoide ?

7th. Approximation: Petrocalcic Argiudoll ?

F.A.O. system:

Notes:

SITE 20 - (36°32' S - 59°36' W) Profile "Parish"

Location: 3 km E of Parish, province of Buenos Aires. Elevation: 87 m.

Soil profile description:

A1 0-15 cm. Black (10YR 2/1, moist) clay loam; fine subangular block structure; plastic, sticky; common lime concretions; clear, smooth boundary.

B21t 15-35 cm. Very dark brown (10YR 2/2 moist) clay; coarse medium prismatic structure breaking to angular blocky; plastic, sticky; common lime concretions; many clay skins; few, fine prominent iron mottles.

B22tg 35-50 cm. Dark brown (7.5YR 3/2 moist) clay; medium angular blocky structure; plastic, sticky; abundant lime and iron-manganese concretions; many, very dark grayish brown (10YR 3/2) clay skins; abundant, fine, prominent iron mottles.

IIRca(IICca) 50+ cm. Pinkish gray (7.5YR 7/2 moist); indurated calcareous duripan (weakly cemented in the upper portion)

Soil classification (tentative)

Argentine map: Gley subhúmico con tosca (Low humic gley) o Brunizem hidromórfico somero (con tosca).?

7th. Approximation: Petrocalcic Argiaquoll ?

F.A.O. system:

Notes:

SITE 21 - (35°58' S - 59°01' W) Profile "Las Flores"

Location: 8 km NE of Las Flores, province of Buenos Aires. Elevation: 28 m.

Climatic data:

	J	F	M	A	M	J	J	A	S	O	N	D	An.
T°C	23.0	21.8	19.4	15.4	11.5	8.5	8.6	9.6	12.3	14.9	18.4	21.2	15.4
Pp mm	77	86	112	102	73	54	48	49	80	65	83	93	922
Pot. Evap. mm	134	103	87	54	32	18	20	25	40	61	88	120	782

Soil profile description:

Ap 0-15 cm. Very dark gray (10YR 3/1 moist) sandy loam; weak medium subangular blocky structure breaking to granular; very friable; abrupt, smooth boundary.

A1 15-20 cm. Very dark gray (10YR 3/1 moist) sandy loam; weak medium subangular blocky structure breaking to granular; very friable, nonsticky, non-plastic; krotowines; gradual, wavy boundary.

A2 20-40 cm. Dark brown (10YR 3/3 moist) sand; weak medium and coarse platy structure, breaking to single grain; loose; with krotowines, abrupt, smooth boundary.

B21t 40-52 cm. Brown to dark brown (10YR 4/3 moist) heavy clay; strong, coarse prismatic and columnar structure; hard, firm, very sticky, very plastic; many iron-manganese concretions; abundant, prominent medium brown mottles (7.5YR 4.5/4); abundant very dark gray brown (10YR 3/2) clay skins; gradual, wavy boundary.

B22t 52-85 cm. Dark yellowish brown (10YR 4/4 moist) clay loam; coarse prismatic structure breaking to sub-angular blocky; friable; very plastic, slightly sticky; moderate calcareous concretions, many prominent iron mottles; gradual, wavy boundary.

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SITE 21 cont.

B31x 85-150 cm. Dark yellowish brown (10YR 4/4 moist) sandy clay loam; weak, coarse subangular blocky structure; breaking to single grain; friable; very hard when dry; plastic, slighty sticky, many iron-manganese and calcareous concretions; few clay skins; common mottles; weakly developed fragipan.

C 150 + cm. With water level.

Soil classification (tentative)

Argentine map: Brunizem planosólico (con fragipán)

7th. Approximation: Fragiaquollic Argialboll ?

F.A.O. system:

Notes:

SITE 22 - (35°22' S - 58°47' W) Profile "Abbott"

Elevation: 29 m.

Location: Km 100 highway N° 3 near Abbott, province of Buenos Aires.

Soil profile description:

A1 0-17 cm. Very dark brown (10YR 2/2 moist) loam; moderate medium subangular blocky structure; friable; slighty plastic, nonsticky; abundant roots; clear smooth boundary.

A2 17-22 cm. Very dark grayish brown (10YR 3/2 moist) sandy loam; thin, weak, platy structure to massive; friable; nonsticky, nonplastic, abrupt, smooth boundary.

B2t 22-50 cm. Brown to dark brown (7.5YR 4/2 moist) heavy clay; coarse prismatic structure; friable; plastic and sticky, many, very dark brown (10YR 2/2) clay skins; prominently mottled. Lime and iron-manganese concretions in the lower part; clear, wavy boundary.

B3x 50+ cm. Brown to dark brown (7.5YR 4/3 moist) sandy clay loam; massive, hard, many iron-manganese concretions, few clay skins; with water in a meter.

Soil classification (tentative)

Argentine map: Planosol (con fragipán)

7th. Approximation: Umbric Fragiaqualf or Typic Argialboll (Fragialboll?)

F.A.O. system:

Notes:

SOIL CORRELATION TABLE - PAMPEAN REGION EXCURSION

SITE	PROFILE	ARGENTINE MAP	7th.APPROXIMATION	F.A.O. SYSTEM
1	Solís series			
2	Pergamino series			
3	Rojas series			
4a	Junín series			
4b	Teodelina series			
5	Saforcada series			
6	Merceditas series			
7	Venado Tuerto series			
8	Canals			
9	Agua Dulce			
10	Malena			
11	Huinca Renancó			
12	Realicó			

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SITE	PROFILE	ARGENTINE MAP	7th.APPROXIMATION	F.A.O. SYSTEM
13	Winifreda			
14	Santa Rosa			
15	Pellegrini series			
16	Tejedor series			
17	Nueva Plata			
18	Cantera Olavarría			
19 a	Escuela de Agricultura a			
19 b	Escuela de Agricultura b			
20	Parish			
21	Las Flores			
22	Abbott			

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Third South American Soil Correlation Meeting for the Soil Map of the World

ANNEX

ANALYSES OF THE SOIL PROFILES

ANALYSES OF SOLIS SERIES (Site 1)

(These data don't belong to the same profile)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq.%
Ap	0.0	0.0	0.6	10.1	53.6	26.7	2.3	0.2	0.0
A12	0.0	0.0	0.4	8.8	56.0	28.5	2.3	0.2	0.0
B1	0.0	0.0	0.4	12.4	52.6	30.0	1.7	0.14	0.0
B21	0.0	0.0	0.3	4.1	35.1	58.8	0.8	1.07	0.0
B22	0.0	0.0	0.2	6.3	35.4	56.6	0.5	0.05	0.0
B23	0.0	0.0	0.3	7.1	41.1	50.5	0.33	0.04	0.0
B3ca	0.0	0.0	0.4	7.2	61.5	27.9			1.2

Horizon	C.E.C.	Cation m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	E.C. mmh/cm	% Base satur.
Ap	23.6	15.7	2.2	1	0.7	9.1	5.6	0.3	82
A12	23.5	15.5	2.4	1.0	0.4	9.0	5.6	0.3	82
B1	24.3	15.7	3.2	0.7	0.4	8.7	6.0	0.3	82
B21	47.5	29.8	5.4	1.5	0.5	11.1	6.4	0.3	78
B22	37.8	26.0	4.2	2.0	0.8	8.5	6.9	0.3	88
B23	32.5	26.6	2.1	2.1	0.5	7.0	7.4	0.3	98
B3ca	37.5	28.5	3.8	2.2	1.0	-	8.3	0.3	100

ANALYSES OF PERGAMINO SERIES (Site 2)

(These data don't belong to the same profile)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
Ap	0.3	0.8	7.8	10.6	62.2	18.3	1.27	0.13	0.0
A12	0.0	0.2	1.5	12.7	59.2	26.4	1.05	0.13	0.0
A3	0.0	0.0	1.0	10.6	58.5	29.7	0.76	0.115	0.0
B1	0.0	0.1	1.7	1.1	64.3	32.8	0.58	0.1	0.0
B21	0.0	0.0	0.9	9.6	49.4	40.1	0.43	0.07	0.0
B22	0.3	0.2	2.0	11.8	52.9	32.8	0.35	0.05	0.0
B3	0.3	0.6	7.2	8.8	62.4	20.7	0.17	0.036	0.0
C	0.8	1.0	5.5	9.3	68.8	14.4	0.09	0.03	0.0

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH paste	% Base satur.
Ap	17.9	10.2	2.1	1.9	0.5	5.9	5.9	5.2	82
A12	19.8	12.5	2.3	1.8	0.5	5.5	6.2	5.2	86
A3	20.9	13.3	3.2	1.9	0.5	5.0	6.6	5.8	90
B1	22.8	15.4	2.8	2.0	0.5	5.0	6.8	5.8	91
B21	31.6	21.0	4.4	2.3	0.5	5.5	6.9	6.0	89
B22	30.0	22.1	4.4	2.2	0.5	5.3	7.1	6.1	94
B3	26.9	17.6	4.3	1.8	0.5	4.3	7.1	5.9	90
C	27.4	18.9	5.2	1.5	0.5	3.7	7.1	6.1	95

ANALYSES OF ROJAS SERIES (Site 3)

(These data don't belong to the same profile)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.0	0.0	0.5	17.9	55.8	25.8	1.98	0.224	0.0
B1	0.0	0.0	0.2	17.0	51.8	31.0	0.98	0,11	0.0
B2	0.0	0.0	0.4	14.6	44.5	40.5	0.66	0.09	0.0
B3	0.0	0.0	0.8	22.7	61.0	15.5	0.23	0.04	0.0
C	0.0	0.0	2.0	28.1	58.1	11.8	0.12	0.02	0.0

Horizon	C.E.C	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH 1N KCl	% Base satur.
A1	21.9	12.7	3.1	2.3	0.3	4.2	5.4	4.8	84
B1	20.5	12.0	2.9	1.5	0.4	3.2	6.1	4.9	82
B2	26.7	17.7	4.7	1.6	0.4	3.2	6.5	4.9	91
B3	20.8	13.6	4.7	1.4	0.4	2.1	6.8	4.8	97
C	19.5	12.0	3.8	1.8	0.4	2.6	7.0	5.0	92

ANALYSES OF JUNIN SERIES (Site 4a)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
Ap			2.1	51.3	31.1	15.5	1.19	0.12	0.0
A12			2.3	44.7	34.0	17.9	1.12	0.11	0.0
B2			2.9	42.7	35.5	18.9	0.51	0.05	0.0
B3			3.1	49.0	35.0	12.9	0.25	0.03	0.0
C			3.6	52.5	33.5	10.5	0.12	0.02	0.0

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH 1N KCl	% Base satur.
Ap	17.4	8.6	3.8	2.2	0.4	3.1	6.4	5.5	86
A12	18.2	10.6	2.7	1.8	0.4	3.6	6.3	5.3	85
B2	16.1	8.8	3.2	1.8	0.4	2.1	6.5	5.2	88
B3	13.8	7.3	3.1	1.8	0.4	1.6	6.9	5.4	91
C	13.1	7.2	3.3	1.1	0.4	0.5	7.3	5.7	92

ANALYSES OF TEODELINA SERIES (Site 4b)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.0	0.0	1.1	36.8	38.0	24.1	1.87	0.181	0.0
AB	0.0	0.0	1.5	40.4	32.2	25.9	0.90	0.099	0.0
B21	0.0	0.0	1.5	38.8	30.4	29.3	0.72	0.096	0.0
B22	0.0	0.0	1.4	38.3	33.6	26.7	0.41	0.060	0.0
B31	0.0	0.0	2.1	44.0	32.3	21.6	0.32	0.045	0.0
B32	0.0	0.0	2.4	47.2	39.5	10.9	0.19	0.031	0.0
C	0.0	0.0	2.6	54.9	32.7	9.8	0.12		0.0

		Cations m.e./100							
Horizon	C.E.C.	Ca	Mg	K	Na	H	pH 1:2,5	pH paste	% Base satur.
A1	24.9	16.5	2.9	1.6	0.5	4.2	6.1	5.5	86
AB	20.0	12.2	2.9	1.4	0.4	3.6	6.2	5.6	84
B21	20.0	12.4	2.7	1.5	0.4	3.2	6.4	5.7	85
B22	19.6	10.2	3.6	1.9	0.4	2.6	6.5	5.9	82
B31	19.4	10.0	4.5	1.8	0.4	2.1	6.6	6.0	86
B32	18.2	9.6	4.1	2.1	0.4	1.1	6.9	6.3	89
C	16.9	9.4	4.0	2.3	0.4	0.5	7.1	6.6	95

ANALYSES OF SAFORCADA SERIES (Site 5)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A11	0.0	0.0	7.6	56.2	25.0	11.2	0.87	0.096	0.0
A12	0.0	0.0	7.9	46.9	32.0	13.2	0.71	0.078	0.0
AC1	0.0	0.0	32.0	40.0	16.0	12.0	0.37	0.065	0.0
AC2	0.0	0.0	34.8	38.0	17.1	10.1	0.21	0.048	0.0
C1	0.0	0.0	39.3	34.6	17.6	8.5	0.12		0.0
C2	0.0	0.0	49.3	23.2	19.2	8.3	0.10		0.0

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	% Base satur.
A11	12,9	6.8	1.4	1.1	0.5	3.6	5.7	76
A12	14.4	7.9	2.3	0.9	0.5	2.1	6.2	80
AC1	13.1	7.3	1.6	0.9	0.3	1.5	6.5	77
AC2	12.1	6.6	2.5	0.8	0.3	1.5	6.6	84
C1	11.8	6.1	2.4	0.8	0.4	1.0	7.1	82
C2	12.3	6.1	2.6	0.9	0.5	0.5	7.0	82

ANALYSES OF MERCEDITAS SERIES (Site 6)

(These data don't belong to the same profile)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
Ap	0.0	0.0	1.6	41.2	38.1	19.1	1.83	0.17	0.0
A12	0.0	0.0	1.4	36.8	40.6	21.2	0.96	0.09	0.0
B2	0.0	0.0	1.5	41.1	35.1	22.3	0.53	0.055	0.0
B3	0.0	0.0	2.0	44.8	33.9	19.3	0.27	0.03	0.0
C1	0.0	0.0	2.5	47.2	35.6	14.7	0.1		0.0
C2	0.0	0.0	2.9	50.8	34.5	11.8	0.08		0.0

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH paste	% Base satur.
Ap	19.4	10.2	4.5	2.6	0.7	7.3	6.0	5.7	92
A12	17.8	9.6	4.1	2.1	0.4	5.5	6.9	6.2	91
B2	17.4	8.9	4.0	2.3	0.4	4.9	7.3	6.3	90
B3	15.0	8.0	4.5	2.4	0.3	3.7	7.3	6.8	100
C1	13.4	7.1	5.0	1.2	0.3	2.6	7.5	7.1	100
C2	13.2	6.4	5.0	1.4	0.4	2.2	8.2	7.4	100

ANALYSES OF VENADO TUERTO SERIES (Site 7)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
Ap	0.0	0.0	1.7	30.5	49.0	18.8	1.83	0.168	0.0
A12	0.0	0.0	5.5	26.8	45.5	22.2	0.99	0.110	0.0
B1	0.0	0.0	8.5	23.6	44.2	23.7	9.81	0.088	0.0
B2	0.0	0.0	7.0	29.5	41.4	22.1	0.48	0.067	0.0
B31	0.0	0.0	8.2	34.0	44.0	13.8	0.17	0.037	0.0
B32	0.0	0.0	9.3	35.5	44.5	10.7	0.16	0.031	0.0
C	0.0	0.0	10.5	32.5	50.5	6.5	0.09	0.024	0.0

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH 1N KCl	% Base satur.
Ap	20.5	12.2	2.9	2.3	0.7	3.6	6.1	5.4	88
A12	19.5	11.9	2.7	2.0	0.6	3.6	6.2	5.3	88
B1	20,2	11.9	2.9	1.7	0.6	2.8	6.2	5.2	85
B2	18.7	11.4	3.6	1.6	0.6	2.6	6.5	5.1	92
B31	16.7	8.7	4.2	1.8	0.6	1.6	6.6	5.2	92
B32	15.6	8.5	3.9	2.1	0.6	1.0	7.0	5.4	97
C	15,5	8.8	3.4	2.4	0.6	1.1	7.2	5.6	98

ANALYSES OF PROFILE CANALS (Site 8)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.0	0.0	2.0	55.5	28.5	14.0	1.21	0.158	0.0
AC	0.0	0.0	4.0	55.8	30.0	10.2	0.54	0.080	0.0
C	0.0	0.0	6.2	64.1	22.5	7.2	0.12	0.026	0.0

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH 1N KCl	% Base satur.
A1	18.3	8.5	3.1	1.9	0.3	3.6	5.7	5.0	75
AC	15.5	7.4	2.9	1.4	0.5	2.5	6.2	5.1	79
C	12.3	7.2	2.9	1.3	0.5	0.5	7.3	5.8	97

ANALYSES OF PROFILE AGUA DULCE (Site 9)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
Ap	0.0	0.5	10.1	52.7	27.0	9.7	1.15	0.130	0.0
A12	0.0	0.5	6.3	60.0	22.5	10.7	0.78	0.090	0.0
AC	0.0	0.6	9.7	59.8	21.0	8.9	0.44	0.062	0.0
C1	0.0	0.0	34.5	37.6	21.0	6.9	0.16	0.031	0.5

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH 1N KCl	% Base satur.
Ap	15.6	7.3	2.4	2.1	0.3	2.6	6.1	5.2	78
A12	15.2	7.6	2.5	2.0	0.3	1.5	6.3	5.4	82
AC	13.3	7.2	2.5	1.5	0.4	1.0	6.7	5.6	87
C1	9.9	7.9	1.8	1.2	0.6		8.2	7.1	100

ANALYSES OF PROFILE MÅLENA (Site 10)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq.%
A1	1.1	2.4	17.0	36.9	30.5	12.1	1.03	0.120	0.0
AC	1.5	2.7	22.5	40.4	22.4	10.5	0.50	0.070	0.0
C	1.3	2.8	52.7	14.3	19.2	9.6	0.09	0.024	0.1

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH 1N KCl	% Base satur.
A1	15.2	6.6	3.1	1.7	0.5	2.6	6.3	5.5	78
AC	14.7	6.8	3.3	2.5	0.4	1.5	6.4	5.3	88
C	9.8	6.3	2.7	1.7	0.5	-	8.3	7.0	100

ANALYSES OF PROFILE HUINCA RENANCO (Site 11)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	1.8	6.1	30.0	36.0	16.5	9.6	0.73	0.07	0.0
AC	1.7	6.2	32.5	36.1	13.9	9.1	0.4	0.037	0.0
C1	2.0	6.8	32.6	36.2	13.9	8.2	0.21	0.028	0.0
C2ca	2.0	7.4	34.1	39.1	10.8	4.7	0.12		1.6

AC, C1, and C2ca horizons have very coarse sand : 0.5-0.3-0.3

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	E.C. mmh/cm	% Base satur.
A1	11.2	6.2	2.8	1.7	0.2	5.1	6.4	0.1	97
AC	10.7	6.0	2.9	1.4	0.1	4.5	6.7	0.1	97
C1	9.4	6.0	3.1	0.6	0.2	3.7	7.3	0.1	100
C2ca	4.8			0.9	0.4	-	8.2	0.1	

ANALYSES OF PROFILE REALICO (Site 12)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.9	1.8	20.4	27.5	32.8	16.6	1.28	0.12	0.0
AC	0.9	2.3	20.0	31.1	29.5	16.2	0.67	0.067	0.0
Cca	0.7	2.0	21.0	31.2	28.7	12.3	0.31	0.04	3.8

Cca horizon has very coarse sand : 0.3.

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	E.C. mmh/cm	% Base satur.
A1	19.1	11.7	3.9	2.5	0.3	7.3	6.9	0.1	96
AC	18.9	15.4	3.4	1.7	0.3	4.6	7.6	0.1	100
Cca	16.5			2.7	4.5		9.0	0.3	

ANALYSES OF PROFILE WINIFREDA (Site 13)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.5	1.4	12.9	18.3	46.6	20.3	1.44	0.14	0.0
AC	0.8	1.7	16.3	19.8	42.7	18.7	0.68	0.06	0.0
C1	0.9	1.9	17.5	21.8	40.0	17.9	0.5	0.05	0.0
C2ca	0.9	2.0	19.5	23.3	37.4	16.0	0.43	0.05	0.9

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	E.C. mmh/cm	% Base satur.
A1	23.5	11.4	4.8	2.8	0.3	7.8	5.9	0.2	82
AC	22.9	14.0	5.3	2.5	0.4	6.0	7.0	0.1	97
C1	23.5	15.9	4.5	1.8	0.3	5.6	7.1	0.1	96
C2ca	29.0			0.8	0.7		7.8	0.2	

ANALYSES OF PROFILE SANTA ROSA (Site 14)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.6	1.4	8.6	25.7	48.3	15.4	2.12	0.210	0.0
AC	1.1	1.6	9.9	24.2	46.8	16.4	1.33	0.130	0.0
C1ca	1.2	1.8	10.5	27.7	42.4	13.8	0.99	0.099	2.6
C2ca	1.2	2.0	10.2	28.3	41.1	13.0	0.62	0.063	4.2

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	% Base satur.
A1	24.5	17.2	3.2	2.3	0.3	8.6	6.1	94
AC	25.1	20.3	3.4	1.9	0.4	5.8	7.4	100
C1ca	24.1	-	-	0.9	0.6	-	8.0	-
C2ca	24.8	-	-	1.0	0.7	-	7.9	-

ANALYSES OF PELLEGRINI SERIES (Site 15)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	2.3	11.6	39.1	15.6	19.8	11.6	0.84	0.079	0.0
AC	2.4	10.7	43.0	17.2	17.4	9.3	0.13	-	0.0
C1	2.4	11.9	43.5	17.8	15.6	8.8	0.13	-	0.0
C2ca	2.8	13.4	48.1	18.7	10.1	6.8	0.05	-	Vest.

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH 1N KCl	% Base satur.
A1	11.3	5.4	2.9	2.0	0.3	6.8	6.8	5.1	94
AC	10.0	5.4	3.0	1.9	0.2	4.3	7.5	5.6	100
C1	9.8	4.5	3.2	2.0	0.2	3.5	7.6	5.6	100
C2ca	13.8	4.1	4.4	1.4	4.2	-	9.1	7.1	100

ANALYSES OF TEJEDOR SERIES (Site 16)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.0	0.8	7.5	14.0	59.1	18.6	3.02	0.301	0.0
A2	0.2	1.2	7.3	13.1	62.8	15.4	0.41	0.042	0.0
B2(sa?)	0.3	1.9	14.7	22.1	41.3	19.7	0.27	0.022	0.0

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	E.C. mmhos/cm	% Base satur.
A1	28.1	13.9	9.9	2.5	0.9	6.6	6.8	0.5	97
A2	-	10.1	9.6	2.6	6.6	-	8.6	1.58	-
B2(sa?)[@]	-	-	-	-	-	-	8.1	16.6	-

@. - Extr. satur. : Ca^{++} 12.3; Mg^{++} 17.5; Na^{+} 148.; K^{+} 1.
HCO_3^{-}: 4.4; Cl^{-} 152.0; SO_4^{-} 32.0.

ANALYSES OF PROFILE NUEVA PLATA (Site 17)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.2	2.8	24.1	15.2	37.1	20.6	2.55	0.297	0.0
AC	0.3	3.4	28.5	13.1	41.2	13.5	0.74	0.085	0.0
IIA2	0.8	4.2	37.9	11.8	37.7	7.6	0.28	0.033	0.0
IIB2	0.8	4.1	27.5	18.6	36.0	13.0	0.23	0.032	0.1
IIB3	1.0	4.4	34.7	16.6	33.3	10.0	0.10	0.024	1.6
IIC	1.1	5.3	37.8	20.0	25.8	10.o	0.06		0.2

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH 1N KCl	% Base satur.
A1	25.9	13.3	3.2	2.8	0.6	4.2	5.8	5.0	77
AC	16.5	8.8	3.8	1.3	0.8	1.6	7.1	5.7	89
IIA2	11.1	4.1	3.3	1.0	1.2	0.5	7.8	5.9	86
IIB2	12.9	4.7	4.3	1.8	3.1	-	8.0	6.0	100
IIB3	13.8	4.9	2.2	2.3	5.1	-	9.2	7.5	100
IIC	11.6	2.4	1.7	2.1	6.3	-	9.5	8.1	100

ANALYSES OF PROFILE ESCUELA DE AGRICULTURA a (Site 19a)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.0	0.3	28.5	22.8	28.7	19.7	1.90	0.198	0.0
B2	0.0	0.1	36.5	17.4	21.0	25.0	0.56	0.082	0.0
B3	0.0	0.0	40.6	23.9	22.5	13.0	0.14	0.024	0.0

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	pH 1N KCl	% Base satur.
A1	21.0	13.5	2.5	1.4	0.7	3.1	6.3	5.7	86
B2	20.1	12.6	3.5	0.7	0.5	3.1	6.3	5.1	86
B3	15.0	8.6	3.5	0.5	0.5	1.0	6.8	5.3	87

ANALYSES OF PROFILE ESCUELA DE AGRICULTURA b (Site 19b)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	-	-	-	-	-	-	2.88	0.279	2.3
B2	-	-	-	-	-	-	2.38	0.257	2.7

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2,5	% Base satur.
A1	-	25.6	7.8	1.7	1.2	-	7.8	-
B2	-	29.1	6.5	1.5	1.8	-	7.9	-

ANALYSES OF PROFILE PARISH (Site 20)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.0	0.3	8.4	34.9	42.9	13.5	1.43	0.158	0.6
B21	0.0	0.1	3.0	21.9	41.0	34.0	0.74	0.093	1.1
B22	-	-	-	-	-	-	0.25	0.042	17.0

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH p:2,5	E.C. mmh /cm	% Base satur.
A1	18.3	8.8	4.7	1.3	4.6	-	9.2	2.5	100
B21	36.3	6.8	8.9	3.1	18.5	-	9.3	3.5	100
B22	28.3	4.2	7.5	1.7	16.7	-	9.6	2.7	100

ANALYSES OF PROFILE LAS FLORES (Site 21)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.0	0.0	7.0	47.0	35.5	10.5	1.94	0.252	0.0
A2	0.0	0.0	8.6	61.8	22.4	7.2	0.20	0.026	0.0
B21	0.0	0.0	4.7	43.6	25.1	26.6	0.27	0.057	0.0
B22	0.0	0.0	8.1	39.8	41.4	10.7	0.24	0.049	[illegible]
B31	0.0	0.0	17.3	40.8	37.7	4.2	0.06	-	0.7

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2.5	E.C. mmhs/cm	% Base satur.
A1	19.6	9.7	4.7	1.5	2.9	0.4	8.0	-	96
A2	7.6	2.6	1.4	1.1	2.0	-	8.9	-	[illegible]
B21	23.0	8.1	5.0	2.3	6.5	-	8.7	0.7	95
B22	21.6	7.5	6.5	2.2	5.4	-	9.1	1.4	100
B31	15.4	6.2	4.3	2.1	3.4	-	8.9	-	100

ANALYSES OF PROFILE ABBOTT (Site 22)

Horizon	Coarse sand	Medium sand	Fine sand	V.fine sand	Silt	Clay	C%	N%	$CaCO_3$ Eq. %
A1	0.0	0.0	13.5	17.9	56.9	11.7	1.87	0.213	0.0
A2	0.0	0.0	10.9	25.9	52.3	10.9	0.65	0.097	0.0
B2	0.0	0.7	4.9	14.0	35.6	44.8	0.67	0.094	0.0
B3	-	-	-	-	-	-	0.04	-	1.4

Horizon	C.E.C.	Cations m.e./100 Ca	Mg	K	Na	H	pH 1:2.5	pH mmhs/cm	% Base satur.
A1	19.0	9.8	4.5	1.6	1.5	1.5	7.4	-	92
A2	14.1	5.9	3.0	1.5	3.3	-	8.4	-	97
B2	35.0	11.7	8.1	3.7	11.2	-	8.5	0.2	99
B3	18.1	7.2	4.9	2.1	4.7	-	9.2	-	100