中華教育文化基金董事會委託土壤調查

實業部地質調查所

國立北平研究院地質學研究所

土壤專報

第四號

民國二十一年五月

綏遠薩拉齊區土壤報告

潘德頓　常隆慶　陳偉　侯光炯

北平西城兵馬司九號本所印行

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緒言

一區域內土壤調查之目的、乃以求土壤之概性、及其分佈範圍、及其關於農業性質並以爲本區內農業發展方法之指導。

此報告中材料、係民國二十年六月綏遠薩托民生渠舉行放水禮時、在短促期間所搜集。在此時期之野外工作、有良好之機會以觀察若干里相當新鮮之露出土層。關於土壤及農業事實、曾攝有一百張以上之照片、茲擇十六張附印於此、以示其中較爲顯明之土壤及地形。在此次調查中、所採之土壤標本、以適宜儀器未克全備、尚未盡量研究、當俟諸異日補充之。

此次調查係中華教育文化基金董事會委託地質調查所舉辦。野外工作、多承華洋義　會工程股諸君助力、於住所及運輸上、予以便利。

本區概述

本區屬綏遠、爲內蒙古之一部。地在歸化城之西、包頭鎮之東。位於東經一一〇度二〇分至一一一度、北緯四〇度二〇分至四〇度四〇分之處。其範圍南北約四〇公里、東西約八〇公里、約如三角形、陰山界其北、

黃河界其西南、西海子及黑河則界其東部。

地形差異殊大、北部之峻嶺高出平原數百公尺、極爲陡峭。（圖一一、一六）自山麓伸出一帶之冲積扇形地、成一帶狀之地、寬自二至九公尺。（圖一一、一三、一六）其餘地域、則皆爲幾乎平坦或水平之黃河近代冲積平原。此平原上、尙有蜿流其上之古昔河道（圖二）。拔海高度、約爲九八九公尺至九九五公尺、在以東之歸化站則爲一〇四五公尺。

本地水流情形極異、有短而陡之山澗、流至平原、造成冲積扇形地（圖一三、一四）。主要溪澗皆流向西南。大多數之山澗皆流沒於平原之中、而無湖泊及入正流之通道。但在土較粘重而距河道較遠之東部、則有爲間歇湖之西海子、而自東北東來入本區者、有黑河、其在托克托附近、亦有時能輸水於黃河也。

人民大部自東部及東南部移來、有小部爲蒙古族。但以大旱凶饑之故以死亡流離而減少之人口實多。據聞本地人民約有百分之九五爲農民、大多數皆來自山西。其他則從事於採掘煤鑛淘土製鹽及經營商業。薩拉齊縣之人口、蓋約如薩拉齊區之人口、其在民國十八年有四五〇〇〇戶約有三三〇〇〇〇口、此數約爲每平方里有二人、或每平方公里有八人。

本區交通全恃平綏鐵路線、此線經行本區之北、而西至距本區西界一〇公里之包頭鎭。黃河在運輸各種商品上、亦殊重要。本地運輸、在平原上多用大車、其在山地運煤以供本地消耗及轉運別處者、用驢及駱駝。在本區內無良好之車道及馬路、僅有車轍土路合於行駛輕汽車、且每年中、大多數之時日、皆可利用。

本區主要市場爲薩拉齊城、其西之包頭鎭及東南之托克托城亦重要。歸化城雖在一〇〇公里以東、亦

爲一中心市場也。

土壤圖及報告

名詞定義　質地　指土壤本質之粗細及造成土壤顆粒之大小及其結合之數量或其全體性質。

構造　此名詞表示單粒及聚體之排列法。又可以指在原位及未變動之土壤天然的排列方法、或在任何變動程度之土壤。

土壤剖面　爲自地面至在下之未風化物質之土壤垂直剖面。

土系　爲一系之土壤、有相同之剖面性質、(有同等之顏色、構造、堅實度、及相同之層次次序、及層次發達之程度、)地勢及排水之通性亦同、且常有同一或相似之成因。一系之諸土類、除表土之質地外、一切皆極近似。

土類　一種土壤、自其分布全體而言、有相當一致之表土質地、及相當一致之剖面性質、卽自成一類作爲土壤圖之單位。

所附之土壤圖及報告之根據、皆係搜集於野外調查。在調查時曾多觀察露出之剖面、多作鑽孔、多照像片、及搜集本地報告。以時間有限及運輸之不便、調查工作極受限制。因此、在此土壤圖上、土類之分佈、以塗色及畫線之兩種方法表示。塗色區域指示其爲我等實地勘測者、其以同色畫線之區域、則爲未曾實際走到者、惟推想情形、當屬諸所示者耳。

所用之底圖爲陸軍測量局之十萬分一地圖、此圖有時非常準確、但未經三角測量、例如新開諸渠道、皆

自地上實測、確爲直線而平行者、但置諸底圖之上、以經過區域之地名爲準、則諸渠道皆彎曲而不平行。由此可知此諸村莊之地位未能精確測繪。又在山坡上之地形、亦有未盡準確之處、如在麥達召是。在此次調查、皆未能重製新圖以改正此諸誤點。

土壤通論

概言之、本區土壤、分爲四組。(一)廣大之黃河冲積平原、(二)沿山麓一帶之冲積扇形地狹帶、(三)討子號附近極小面積之有機質土壤、(四)在陡坡上之薄而陡之殘留土。

組成冲積平原之土質、多來自黃河上流、而經遠道搬運之黃土。自黃河上流各溪流侵蝕而來之者、較堅物質已極少見、或竟未有。冲積扇形地爲岩石碎塊所造成、由於陰山之侵蝕及風化。此項扇形冲積內並無混有黃土之證據。即有黃土當被冲入平原中、而混於自黃河冲來之土質也。

在薩拉齊以東約九公里之新農試驗場之深井記錄、據巴爾博所轉述者、以爲此地之新地史與華北各地區域頗爲近似。其相當之系統如下：八公尺（二五英尺）之黃土狀層、似同於馬蘭期之沉積、再下卽屬三門期及上新統。此處共爲五五公尺（一八八英尺）之累積層、底部之一二公尺（四〇英尺）爲黑泥。

巴爾博又言、泥炭累積、當爲洪積期後之初期遺物、蓋在馬蘭期與今日之間、有氣候之轉變也。在他處亦有左證、以示當此氣候轉變之時、大面積之河流冲積與黃土質相混雜。泥炭層、位於表土之下、而多少影響及於表面土質、成爲討子號系之土壤。在或種地帶、此種泥炭層與現代泉水及低地亦似有關係、以引起較多之有機質之聚積、至低限度、可以供給充足之水分以減少在乾燥氣候下引起之分解作用也。此項泥炭層、多位

於冲積扇形地之邊緣、及可望有泉水之低地中。

以山地如此之陡峭、致土質堆積、殊少機緣。山坡間有土壤者、爲純粹殘留物及少許之風積土之混合物也無疑。風化之力、進行極慢、以普通情形皆極乾燥也。

本區植物極稀、爲草原地應有之現象。主要作物、皆在冲積扇形地及平原中。而在扇形地下部、及平原中之某一部、更爲發達。以山羊之嚙食、及樵夫之砍伐、故留存於山中之樹木亦極少。

本區土壤

在本區中、面積極大之土壤爲綏遠系、包有黃河冲積之廣大平原。其屬冲積扇形地者爲薩拉齊系。其爲小面積之有機質土壤者爲討子號系。

綏遠系　本系土壤爲淡灰棕色、半灰棕色、並有時在野外爲棕灰色。當潤濕時其色更稍變棕。在此系中各土區表土之質地爲自極細砂壤（壚坶）或泥壤至粘壤土、包有可爲緩水流冲動之顆粒。此諸質料、爲黃河在極近世之地質時期之所累積。黃河曾蜿曲於此平原上、其故道仍可隨處察出（圖二）其最清楚者、已示於土壤圖上。此冲積層時代既新、當地風化作用之進行又極緩、故土壤剖面不甚顯變化之跡。但因河流徙移無定故各冲積層亦時有廣大而急劇之變化。其最顯著之不同、有如粉砂壤土區所示、其色常屢變、自淡灰棕色粉砂土以至於紅棕色之粘土（圖四—九）。以雨量之少故有多量之可溶性鹽類存於土層中。（圖四五及表二）但通常在無過量之水時、在表面鹽類之濃度、尙不足以妨害農作物之生長。所有土壤皆爲石灰質土。本系土壤佔本區非山嶺地帶面積百分之八六以上。

薩拉齊系　包有沿陰山南麓之冲積扇形地。此系土壤、占有自一至九公里寬之地帶。約爲可耕地面積百分之一三。以全體而論、此系土壤、在野外時、爲淡灰棕色、淡棕色、棕色、至暗棕色、當潤濕後、更棕。亦有在濕後、變爲較暗者。

本系土壤、在質地上、爲礫質砂壤、砂壤及壤土、至細砂壤或粉砂壤土。其含量各級皆有、包括諸相、如少數之次生黃土冲積石塊等。較粗質料、當然緊依溪流及谷口、細砂壤則分佈較遠常在緩坡之上、有時且在距谷口若干里外。（圖一三—一五）。

土層變換不同、大部份爲石礫及砂成交錯層、而雜以較細質料。因在現時有扇形地之建設、及本區風化作用之以氣候乾寒而進行遲緩、故甚少土壤發育之痕跡（溶濾層及沉聚層皆無。）此種土壤以鹽酸試之雖發泡極盛、而在表面上則無石灰質結核可尋。

以此種土壤之地位、侵蝕、及下層之疎鬆程度關係、其潛水面、在斜坡上部、有時遠在地面下二〇至二五公尺以下。（六五—八五英尺）且土中含石塊太多、不合於用、除非除此諸石塊於田外。但亦正以此土質之疎鬆而易蓄水。故在谷口扇形地之邊緣能有豐富之潛水、以灌溉在本系中之細砂壤及砂壤土區上之小麥及罌粟及其他作物。換言之、本系土壤之利用雖極困難、而重要農業及有價值之作物、仍全能出產於本系土壤之上。又如在薩拉齊北之谷口、水晶溝門、且常作爲大規模之果園、良以此地土壤較粘重、又有來自谷中之豐富水量以資灌溉也（圖一〇—一五）。以此諸性質、此得地利之土壤、較諸在平原中一般之土壤、其地價貴五十倍之多云。

不需灌溉之作物、爲高粱豆類、小米及甘藷。

溪河變道及氾溢、在耕種地上、大爲有害、有築石堤以防之者、而土壤亦有以人工作成者、蓋作成級形地、而引急流汙水於其上、以使其沉澱聚積也。

在本系土層中、未曾見有硬磐層或其他結核。

討子號系　本系之土在表面爲青或暗青灰色之粉砂壤。在土壤中含有頗多之有機質、分解及未分解者皆有。在心土中之有機質較多於在表土中者。眞正之泥炭、用以爲冬季燃料者在於地面下一公尺處。所採掘之土層如後：

〇—一二〇公分、礫質粉砂壤至輕粉砂壤

一二〇—一五〇公分、深灰色粉砂壤土

一五〇—二一〇公分泥炭、色黑、帶黃斑點

二一〇公分以下、深灰色粉砂尼壤、礫質砂壤等、參看標本二五、二六、

此諸泥炭之累積、其位置似與在冲積扇形地之低下部分之泉水有關係。巴爾博氏之解說、已在上文中引及。在本區中、本系土壤數量極少、僅占全面積百分之〇・〇三、以東仍有較大之面積、在本區以外。在地質圖上所標爲泥炭之諸區域、或全屬於此土系。至在地質圖上所有之泥炭區域、以所曾述及之區域比較之、所占面積、似乎過爲廣大。

在鐵門更下達賴及討兒號亦有小區之泥炭土、此種土壤、有種農作物者、以泥炭在地面下頗深也。

土壤各論

綏遠粉砂壤土　在田間色爲淡灰棕、或間爲淡棕灰、當潤濕時爲淡棕色。質地爲粉砂壤至輕粉砂壤、厚自二〇—四〇公分。六〇公分者少、亦間有至一公尺者。亦有更輕鬆之質地、幾至爲純粉砂質。心土在乾燥時爲淡棕或間爲淡棕灰色之粉砂土。其厚度及在下層質地中之粉砂土、粘壤、或極細砂之排列次序極不規則、如在渠道之新切面上所示者。雖此諸質料之普通性質極爲一致。而在鑽孔中、亦示有極大之變化、粘壤土層、則帶紅棕色。

成因　此質料之全體顯爲黃河所積成、而爲曾被搬運至遠距離者。是以雖土層中有本地質料、爲顯然事實、而所有質料至爲一致。(圖四—八)

地形幾爲平坦之大平原、其中常有溪流水道、此種水道附近、常有是類較輕鬆之相、或有極細砂壤土類。(圖二)

此種土類之年代極新、無風化及以質料之向下變位而起之土層異點。

此種土壤、雖常予人以極壞之印象、然當其未含可溶鹽類或有適宜排水時、實爲良土。其未耕種則以含鹼或屬於蒙古人之故、因彼等不欲開墾其土地、而願以留作牧草場。(圖一、三)有時此種土壤、且以無耕主之故而棄置也。

農作物有小麥、蕎麥、粟、高粱、大麻、亞麻、(用種子)黃豆等、皆低地之標準作物。至罌粟則只限於在較輕鬆之土壤上、即薩拉齊土系也、此地地下水之水源較丰盛。

此種土類、在本區中佔地極廣、計占有平原面積百分之七六（自鄧口以至托克托）其分佈幾及於北部之山下。

在薩拉齊東南東方向約二五—三五公里毛岱鎮前、（土層表九一「註一」）此種土壤有較輕鬆之相、易被風吹起。在爲俊村、距薩拉齊西北三公里有一粉砂壤土之厚累積層、與砂壤土交互成層、其下爲來自北山之其他物質。（土層表八六）在公中之南、距薩拉齊西南約二五公里、在級形地上一公尺下之處、此土之色更見紅棕、濕亦加甚、蓋以地位較低、故以毛細管之力、自潛水面昇水而上、帶多量之鹽類至於地面。（圖一）此種土壤之大部、皆不能耕種、僅用爲牧草場。（土層表七二）土層表六九及在水渠未開掘部分頂部之照片、（圖六）於土質累積之大變易及急流所成之交錯層現相、表示極佳。在粘重土層上有鹽類凝成之華斑。在二十四頃地北約三分之一公里處、有利用鹼土以製取鹼質者。（圖四、五）

註（一）此種土層表指在野外之原有土層記錄、由鑽孔發掘、或天然剖面上得來、皆保存於地質調查所。

在許多地帶、此種土壤之排水皆不良好。

在粘壤土及粉砂壤土接近之地帶、如在大巴拉蓋附近、土層表五一所示、粘壤土上之作物較在粉砂壤土上者爲佳良、此或以水量較多也。

在薩拉齊至托克托之路上、所有土壤、或爲輕鬆粉砂壤、粉砂壤或粘壤。大部分之粉砂壤、或粘壤、皆有含鹽類之表徵、在調查時、大多數土壤之鹽類、其含量並不覺奇重。在或種地帶、當其表面之粉砂壤移去、或心土以溪流之力而露出、如雙龍鎮附近、其在下之粉砂土爲風所吹、輒飛揚天空、此種情形即在新雨之後亦然也。

在民國二十年六月尾、此地尙未種植、即已種植、亦未至大盛。以全體而論、此區予人之印象實爲不佳、此由於見到減少人口之村鎭、破壞之建築、滿路之糞堆及許多未耕種之田地故也。誠然、一部之土壤、含鹼太多、不適耕種、而在確無鹼質之土壤上、其農民亦太少矣。更以在是季之雨量、至我等調查土壤時、尙爲不足也。

在缸房營子周圍、約在薩拉齊東三〇公里、所見之眞正鹼土極少、無鹼質結皮以示有過量之鹽類、且幾無標準之鹼地草類。在此村之北近鐵道處、有瀝土製鹽者、該地有數種植物、可爲土壤含鹽特多之表徵、據在缸房營子之教士言、本村以鹼土關係、僅約有三分之二之地可資耕種、但我等終覺此鹽類過量之現象、由於土壤之物理性質者、較由於土壤之化學性質者爲多。

在薩拉齊東南約十九公里、在九號支渠建築水閘之處、（圖九）約自上面一・八公尺下至二・八公尺、爲暗灰色粘土壤。（標本三、四、土層表六六）此種土壤、顯然爲一種「埋藏土壤」、爲昔日之表土。此事實指示一較老而低下之平原中當有較熟之土壤。約在薩拉齊東一〇公里之新村、所見於地面之土壤似爲此同類之較老土壤也。

綏遠極細砂壤　此土在田間爲極淡棕灰色、當潤濕時、爲淡灰棕色。其質地自極細砂壤、至輕鬆粉砂壤。表土厚自二〇—四〇公分、位於粘壤或粉砂土之上。有時有粉砂土及粘壤或粘土之交互層。

此種土類、爲較速之水流所累積、是以多見於緊依老河道之處。此種土類與粉砂壤土類之間、常無顯明之界線。此次調查、曾未計及將其與粉砂壤土詳細分開、而以在調查上之限制中、亦不可能也。在薩拉齊之南、及東南之許多地域、有零星散播之此種土類、如土壤圖所示、此種土類、約占本區域非山嶺地之百分之三。

農作物有粟馬鈴薯及高粱。在或種地帶、排水困難。較諸綏遠粉砂壤土、爲不肥而價低。

綏遠粘壤土　此種土壤、在田間爲淡灰棕色至半灰棕色、或暗灰棕色、或有時爲棕灰、在潤濕時色稍較棕。表土之質地、爲粘壤、厚自一〇—四〇公分、或更較厚、位於粉砂壤土或粘壤土之心土上。心土則更黃更淡紅、或更暗色。此層亦可位於極細砂土、粉砂土、或粘土之上。蓋以溪流中沉積情形之有變換、故其中有大變換也。自沉積以來、由風化引起之層次上的特性殊少。地形大部平坦、此種土壤、多在較爲低下之處、其排水因此困難。

此種土壤、用以植莜麥及粟、但常常全未耕種。其耕種之少、由於排水困難、由於在表面之大量鹽類、此鹽類之生成或係積水之所引起、其耕種之少又或爲由於土壤粘重之質地、及其耕種上之不便也。

是種土類之土壤、成爲分散之小區域、一在薩拉齊東二八公里、接近於缸房營子。其他之一、約在薩拉齊西二〇公里。土含鹼、價賤而無用。此種土壤之大部、在薩拉齊東南、五〇—六〇公里之處、其地接近討子號。如土壤圖所示、此區之土壤、約占除山嶺地面積百分之七。

在陶思浩（即討子號）車站東南約四—五公里、在西海子之北部、在此海子之邊緣上之粉砂、壤土及在此海子中之粘壤土二者之間、有過渡現象。（土層表八三、八四）此種土壤、在田間爲淡灰至灰色、當潤濕時、爲暗灰色、在地下四〇公分處、其結構爲粗粒狀。以下爲棕色至暗棕灰色之粘壤。（潤濕之色）此處土壤之排水極爲困難、多用爲牧草場、而其中一部、已防以堅堤、已施耕種。有時其地之較粗質料、自在北方之薩拉齊系帶入、則有此種土類之過渡形式。（土層表八二）

薩拉齊細砂壤土所有土壤之色皆不同、在野外自淡灰棕至淡棕灰、潤濕後爲淡棕至半棕色。質地爲細砂壤、有時頗近於壤土或砂壤土。表土之厚度不定、爲三〇—七〇公分或更厚。

心土不同、自砂壤至輕細砂壤、至爲壤土或粉砂壤土。更下、亦可有石礫。—此在短距離間有特別變化、當爲急流中之累積物也。雖有時風力亦助此細物質與較粗之物質分開、而此諸質料之來源、亦當爲冲積扇形地邊上溪流之累積物。此土非常之新、即在現時、仍在河流及風力之建設中、故無發達之土層。以鹽酸試之則發泡、示含有多量之炭酸物、如土壤圖所示、此種土類約有非山嶺地面積百分之五。

以單位面積之價值而言、罌粟爲極重要之農產、其他之園藝作物、及小麥、亦種植於此種土類之上。疎鬆之底層及頗淺之優良潛水、使此種土類、極適合於罌粟及園藝作物。

地形稍有起伏、或近於平、大部分之此種土壤在薩拉齊、其他則與冲積扇形地之邊緣連接。如在下土合氣及麥達召附近東部是。

此種土壤雖輕鬆、亦可以築村屋墻堵及作土磚。

緊接在表土之下、有時有石礫之斷續層、於植物根部之水分減少殊甚。如非加以灌溉、則可引起作物之凋零早死。在西部、大土合氣附近、接近此薩拉齊細砂壤外緣之處、在幹渠道之底部、自表面四公尺以下、爲厚礫石層、是深黃棕之銹色。此色顯然爲自帶入潛水中之鐵質而來。潛水在此地極多、常引起開掘上之困難。石灰質結核亦有發現、粘結在砂及礫石上。

此種土類皆無過量之可溶鹽類、據鄉人言、有一地點、（土層表七九）約在地面下一至二公尺處、亦有

鹼質。

農作物有粟小麥及菜蔬、據言小麥之出產量、每畝有八九斗、（每公畝七六五〇—八六五〇公斤）小米出產量較好者每畝出三四斗、（每公畝出二九〇〇—三八〇〇公斤）其極好者、每畝亦出八九斗、（每公畝七六五〇—八六五〇公斤）地價每畝約值六十五（註二）元（每公畝一千元。）

註（二）指本地錢、其時之價格、約各地通用大洋之半。

薩拉齊砂壤土　此種土區之色、當潤濕時、爲淡棕灰、至暗棕灰。在乾燥時、爲淡灰棕色。僅有一處、在渠岸露出之土層上、在雨濕後、地面下一公尺處之色、全爲極暗之灰色。質地爲砂壤、自細砂壤以至粗砂壤。有時較細質料、爲風吹入於細砂砂丘之中、其遺留者則爲較粗之質料之砂壤土。其中又有頗多之雜質、如瓷片、煤渣、磚塊等。此或爲以村中垃圾與肥料同運至田間之結果也。表土之厚度爲三〇公分。

心土有時頗一致、可至一公尺或較厚、而與表土連續。有時其下層之質料爲粉砂壤土、細砂壤、又或有石礫層、或石礫之間斷層。此種恰在表土下而分佈廣大之石礫層、在乾旱之季、影響於農作物極大。

地形稍有起伏、或近於平原、或其表面爲淺溪流之所分割、或爲此沖積扇形地上之緩坡。在薩拉齊車站之北、以至於山下、又在縣城以東之諸地點、多有此種土類、在討子號附近亦有之。此種土類約占非山嶺地面積百分之四。

所有土壤皆很新、無土層發達之標識、惟在較深之層中、在地面下數公尺以下、有石灰膠結物。

農作物有高粱、罌粟豆類、粟馬鈴薯。據云、如施以灌溉、則每畝可出小麥一石。（每公畝一千公斤）地價

在不能灌溉之地、每畝約自七元至十六元（每公畝一〇〇—二五〇元）在可以灌溉之地、則爲二十元至四十元。（每公畝三二〇—六四〇元）

薩拉齊礫質砂壤土　在田間之色爲淡灰棕、潤濕時、爲半灰棕色。質地在短距離內、亦極爲不同、乃係在冲積扇形地上、溪流湍急、以人工建堤防水及拾去田間石塊、而變易流道之應有情形也。此種土壤、有爲帶石塊之壤土者、有爲礫質壤土者、更有爲砂壤而多少帶石礫者。土壤之厚度頗大。但在其下之物質、則極爲不同。在或種地帶、此種礫質砂壤、已被冲去而露出其下之較老而較粘重較暗色之土壤。

農作物有小米、高粱、馬鈴薯、黃豆及其他豆類。大部分之面積、皆未耕種。因土壤之出產力弱、而多帶石塊不易耕作也。又急流自谷中流出、其侵蝕之力、於農作物上、亦常常有害。

此種土壤、占有沿陰山南坡分佈之冲積扇形地之大部分。而極發達於薩拉齊東北約六至十公里之處。（圖一三—一五）其全面積約爲非山嶺地之百分之三。

薩拉齊壤土　此種土壤、在田間爲半灰棕色、在潤濕時、爲暗灰棕色。質地爲細砂。厚三〇—四〇公分。位於棕色極細砂壤上。地形平。此種土壤、僅有一小區、在薩拉齊之西北、接近板什氣村處。此種土類、約占非山嶺區之百分之〇・二五。農作物爲莜麥、成長頗佳。

薩拉齊粉砂壤土　此種土壤、當潤濕時亦爲灰棕色。其質地爲粉砂壤、又可自砂土、至礫質砂壤。地形爲斜坡狀。此種土壤、位於約在薩拉齊車站、東北四公里之地。爲約當低地面積百分之〇・一之小土類。用以爲植馬鈴薯及小麥之用。

河床冲積　此名詞指在山澗中之石礫及粗砂、姑勿論其氾濫之害、由其質地而言、其大部分之質料、亦無農業價值。此類約占非山嶺區域之百分之〇・四。

山嶺地土壤　指組成在山地表面上之質料。在或種地點、亦有頗重要之土壤、但大多數以山地坡度太陡、而土太薄或全無、故在農業上全無價值。（圖一一、一六）

第一表　各土類之面積

土區	薩拉齊礫質砂壤土	薩拉齊細砂壤土	薩拉齊壤土	薩拉齊粉砂壤土	薩拉齊砂壤土	綏遠粘壤土	綏遠極細砂壤土	綏遠粉砂壤土	討子號土壤	溪流冲積物	共計
勘測 公畝	四七三三	七五一九	五一五	一七八	七〇五九	三四二六	一七四三	四七九四一	五九	八六一	七四〇二四
勘測 百分數	二・三六	三・七五	〇・二六	〇・〇九	三・一五	一・七〇	〇・八七	二三・八六	〇・〇三	〇・四三	三六・八九
估計 公畝	二一八八	三三八六	〇	〇	九七〇	一〇四八	四四一五	一〇五一〇八	〇	〇	一二六五五四
估計 百分數	一・〇九	一・六九	〇	〇	〇・四八	五・二三	二・一五	五二三九	〇	〇	六三・〇三
合計 公畝	六九二一	一〇九一〇	五一五	一七八	八〇三〇	一三九一一	六一五八	一五三〇五〇	五九	八六〇	二〇〇五八四
合計 百分數	三・四五	五・四四	〇・二六	〇・〇九	三・九九	六・九三	三・〇二	七六・二八	〇・〇三	〇・四三	九九・九二

農業

本區農業、發展極壞、蓋原於雨量之不足、及由此而生之乾燥草原地。饑饉之洊臻、及地方之不靖亦大阻農業之發展。在薩拉齊北灌溉優良之果樹區域、其農業較爲進步、卽此可以證明雨量不足爲農業之重要障碍。誠然、在蒙古人所有之地、其注意畜牧、較甚於土地之耕種、此亦本區農業不發達之又一原因。但位於平原之中、屬於天主堂管理之村莊、其繁茂亦未如預期、則殆純由雨量不足之故。此諸村莊有較好之防衞、是以有較爲安全及其他便利之處。

本區域之地價、每畝價值、自一元以下至七十元以上、（每公畝一〇—一〇〇〇元）大多數之土地、多爲三元至二五元一畝、（每公畝五〇—四〇〇元。）每農戶耕種面積、自三十畝至二千畝（二—一二五公畝）

主要農產爲粟、高粱、莜麥、喬麥、小麥、黃豆及其他豆類、芝麻、花生、大麻及馬鈴薯。在薩拉齊系中之農業、以面積論普通作物仍居大多數、但以價值論則罌粟實爲重要作物之一。如能改良灌溉及增加人口、則有廣大之機會以增進農產物也。在現時則大部份之土地多荒廢。種植蔬菜地域之比例率極少、然有謂本地西瓜極佳、有輸出別處者。

農作物在四五月間種植。視雨水遲早而異、至九月收穫。罌粟及園藝作物、以生長在常用井水灌溉之地、其種植自不專恃雨水。土地在下種以後、常用石滾以滾壓之、所以壓緊土壤以引水分自毛細管上升、而促植物之萌芽也。

家畜多限於曳犂及馱物之獸及少許之綿羊山羊、在灌溉進步及耕地加廣時、曳犂獸類之需要亦必增加。更有進者、如缺水問題能得解決、則廐肥之用當較大。廐肥在現時除罌粟地及菜蔬地及用作燃料而外、極爲少用。所有土地、以有機質如此缺乏、故有水時所有田間作物、必當大賴肥料也。

黃河之水、在秋季可自渠道使用於此平原中時、綠肥之爲用及以之在土壤冬凍前、翻於土中、定當爲有利事實。在現時、此種綠肥之施用爲不可能。在一長期中、此地似將不至用任何之化學肥料、除非在罌粟地及他種之特別作物上用之。然淡素肥料似將有時有極好之成績。又聞將來在民生渠灌溉之土地中將不准有罌粟之種植。

在薩拉齊系土壤中、罌粟之種植、極爲普遍、但欲求得關於其種植及產量之確切報告、頗爲困難。據言、如水量充足、則每七八日灌溉一次。每二畝地須用四個全工以耕種整理（每公畝三〇全工）每畝地約施肥二三車、（每公畝二〇—三〇車）各種肥料皆用、然大部分似爲人糞、成車曳出、而置入靠近墻壁之坑中、以使其成熟、然後加水、播於田中。於收取煙漿則用多人巡行田間、需用人工殊多。據聞每畝須在本地繳納約四十元之稅。

灌溉：在現時、本區所用灌溉之法有四種：（一）用井水。此種多限於在薩拉系之土壤、其地之潛水多接近地面、而不含可溶性鹽質。（二）利用水溝以引自山溝中流來之水經薩拉齊土系而及於平原中之綏遠土系之邊緣。（三）果樹及園藝作物之灌溉、則用長流之泉水及在陰山山谷中較大之溪澗。（四）沿本區之東部、在大黑河有水利工事以供給沿河灌溉。而現則將有第五種之增加、即用民生渠中之黃河長流水也。

引用黃河之水、在本省並非創舉、因在上流、在現時仍有廣佈之渠道以灌溉。此在包頭鎮以西之灌溉方法及結果、惜未能考查、將來如有可能、當補爲之、定有許多有價值之點、可以適用於薩拉齊區域也。

在民生渠入口之處、黃河之水、似乎極黃而帶有泥質。但據華洋義賑會在民國十九年及二十年之檢驗、則只帶有百分之二之粉砂及粘土。

土壤中鹽質之過剩

綏遠系土壤中可溶鹽質之多、及其在農業上所引起之困難、前已述及。綏遠系中各種土壤之全體剖面中皆有多量鹽質之存在實爲一不可忽略之事實。（參看第二表各種標本之可溶塊類分析）此諸鹽類、對於農作灌溉隱有極嚴重之危害。蓋在此調查區域中、此種土壤佔有全面積百分之八六也。

據土壤分析之結果（表二）及顯露於新開掘之渠道土壤剖面之觀察、知全土層中、皆有鹽類。（圖四五、八）但以本地雨量之少、土壤中之水分常不足以完全溶解此諸鹽類而使其浸於土壤之中。此爲在綏遠系土壤之表面鹼質之聚積、不見加多之一大原因。

在本區中、綏遠系及薩拉齊系間之界線、有自山中流來之水加入、於土中及地面之上。當此加入之水、流入於綏遠系中較粘重之土有時能蓄成池沼。土中更充足水量、能以毛細管作用自遠距離上昇。此水帶有自土層下部溶來之鹽質、上至地面成白色結皮。如此瘠土僅可用以爲牧草場、及濾製土鹼及食鹽之用。（圖三）

向以土中積聚之全年水量極少、因之被水帶至土壤表面之可溶鹽類、亦不甚多。但今以大規模灌溉系統之建設、使全年無冰期中、增加極豐富之水量、則由此引起之危險恐必甚爲重大。

民生渠告成之後豐富之水量、必將溶解土中全部鹽類。此自幹渠及支渠滲出之水、經過疎鬆之土壤、必即將使全區潛水面上昇、至於約同於渠中水面之高。於是水分在土壤表面上、繼續不斷蒸發、在土壤表面之塊類、遂有繼續不斷之增加。現存於地面下若干公尺處土壤所含之鹽類、雖僅萬分之幾或千分之幾、終將上昇聚集於土壤之表面、其結果將無適宜作物能生長於如此之土壤。因此、此豐富之灌溉水量、其結果之危害、殆將過於此所預期之利益。

第二表　薩拉齊區土壤中之可溶鹽類含量

標本號數	土壤區	地下深度公分	地點	總鹽量(一)	綠化物	硫酸化物	炭酸化物	重炭酸化物
一	綏遠粉砂壤	〇—二〇	侯家營子	一·五六五	六五	一四四	五四	一〇三五
二	仝上	二五—四五	仝上	七六一	八七	二一〇	二五	七六四
三	仝上	一八〇—二〇〇	民生渠第九支渠	八九五	九〇	一四四	二五	六六三
四	仝上	二一〇—二五〇	仝上	七一五	一〇〇	一二一	二〇	六五一
五	仝上	二七〇—二八五	仝上	九二五	一一五	一七一	三六	六三三
六	仝上	〇—二〇	王大發營子	一·一五二	二八八	一三七	二五	六〇六

七	仝上	二五—五〇	仝上	一・三一四	二九八	五三〇	三八	七八二
八		〇—一三	鄔氏圪堆	一九三四	五三〇	九四三	二六	四一四
九		三五—五〇	仝上	一四三四	一四六	二九五	四〇	五〇二
十		表面結皮	八大股	三五一五〇	一〇二五〇	一五〇一二	〇	三七三
十一		〇—二〇	渠上二號橋	二八六〇	五七二	五九九	六六	一〇八四
一二		二五—五〇	仝上	六六八	九〇	九九	一八	五〇〇
一三	綏遠粘壤	〇—二〇	仝上	三九一二	七九三	一四三四	二五	五一四
一四	仝上	三〇—五〇	仝上	一一〇七	二一二	三八三	二〇	六三六
一五	綏遠粉砂壤土	〇—二五	大祥兌	一一五二	七一	八〇	二二	五四三
一六	仝上	三〇—六〇	仝上	六九五	九二	一〇三	一六	五〇九
一七	仝上	〇—二二	七座茅庵	一〇二五	七一	一一九	一二	六二二

一八	全上	三〇—五〇	全上	五八五	六五	一五六	一八	五六八		
一九(二)	薩拉齊細砂壤	〇—二五	小廠圖	三七三〇	一五七五	一五一〇	一八	六二三		
二〇	全上	三〇—五五	全上	六九〇	一四〇	一八九	一四	五六八		
二一	薩拉齊砂壤	〇—三〇	小羊廠	六六六	八一	一四〇	二五	六四六		
二二	全上	四〇—六〇	全上	四八〇	一三五	一七七	二三	四七四		
二三	綏遠粘壤	〇—二〇	陶思浩站	二五四〇	一五二〇	四六九	二三	八一五		
二四	全上	二五—三五	全上	七八〇	二四〇	二〇二	二五	八六九		
二五	討子號粉砂壤	〇—五〇	鐵門更	八四五	一二五	一九七	二〇	七〇三		
二六	全上	一一〇—一五〇	全上	八五〇	二三〇	一五六	二八	六八一		
二七	薩拉齊壤土	〇—三五	板什氣	九〇〇	一四五	二六三	二三	三九六		
二八		四〇—六〇	全上	五六五	八五	二〇六	七	二八三		

二九		○—二○	仝上	三九三○○	一七二二五	一三九○七	○	二五一
三○	綏遠粉砂壤	○—一○	黑麻板	六七三五	二六七五	二一九一	一○	三九四
三一		二○—四○	仝上	八一○	一六五	一七七	一七	四○九
三二		表面結皮	仝上	四三○九○	一四○五○	二○二九三	○	四三六
三三	薩拉齊礫質砂壤	○—二○	大斗林心	四○五	二五	一一五	一五	二九六
三四	仝上	二五—五○	仝上	三七五	七○	一一一	○	三五八
三五	綏遠粘壤土	○—二○	公吉板	七五三○	一八二五	三○一二	一	五○一
三六	仝上	二五—五○	仝上	一二九○	二○○	三七四	二三	六五八

註(一)　包括陽遊子之能溶鹽類總量在事實上不甚可靠(參看 U. S. D. A. Division of Soils. Bull. No. 18, P. 69)

註(二)　在靜置四月後略有紅色沉澱

在他國之過量鹽類之害

大規模之灌溉、其結果之定爲不佳如上所述者、並非虛構。以下爲諸專家意見、及在世界上之乾旱區域中使用大量之灌溉水所發生之事實之說明。

李昂氏及布克滿氏有(註三)言「雖此諸鹽類之一部、爲下次灌溉之水重行帶下、而鹽類之移動向上者、仍超過於向下者。在埃及、印度匈牙利、法國、意國及美國、有大面積之地、因此受害、而常轉至不肥之地位。」

註(三) Nature and Properties of Soils. Rev. Ed. pp. 282-283.

在美國加利弗尼亞州弗里思諾地方、潘德頓曾見一區、其面積約及二萬英畝、在灌溉初年、爲蘩茂之果樹區域。其時之潛水面、在二〇公尺以下由渠水之灌溉及滲洗、無適宜之設備以排除土中過量之水分故潛水面漸至昇高。當潘德頓在其地時、此水已及地面、而諸果樹已皆死於土中過多之水分及地面聚積之鹽類二者之合力下矣。農民因此喪財傾家、而農莊亦淪於荒廢。

茲可述一在美國又一乾燥區域、灌溉設計上之一相類事實。在應用農業上、有一美國鹼土專家、哈里斯氏者、在其「土壤之鹼性(註四)」一書中、關於乾旱土壤之改良有云、「縱在分析上知在表土之下若干距離、有爲鹽類重漬之土層、而土壤表面上之含鹼標識可極少、亦可生長某種之植物。此種土壤若耕鋤而灌溉則心土所含鹽質定將爲危害之源也。……土壤常含少量之鹽類、分佈於較深之處、以灌溉之故、而昇高潛水面至距地面數尺、是供給一理想之境遇、以集中此種分散之鹽類於地面。是使以前出產佳良作物之土壤全變爲不出產之區。故人在作一關於鹼土之巧妙判斷前、潛水情形之通盤了解、殊爲重要。」

註(四) Harris—Soil Alkali, pp. 242, 243.

在印度曾有許多極不幸之經驗、隨灌溉而昇高鹹質、以長久害及土壤、尤以大規模之灌溉爲甚。剛溝里教授、在民國十三年羅馬萬國土壤學會之報告、曾明述此事、謂『在鹼土區推行耕鋤、其令人氣沮之一事、其

足以破壞潛水面之平衡、以引起「鹼質昇高」。印度西北各省之水利局、有鑒於此種煩難現象、在一八七六年設立一專門委員會。此委員會以爲鹼土多存於在農業全恃灌溉之區、及排水天然困難之地面、或涉及任何一種之障礙物、如鐵道堤防等之區域。……印度農業之用古法者、在地面之能溶鹽類、極少增加、但一建築大規模之近代水渠、得使用過量之灌溉水後、鹼類之增加、遂極爲迅速。』

『哈爾氏在印度之鹼土委員會中、曾指出用渠水灌溉而不同時用深排水法、則有使鹼類含量增加之勢、而大面積之土地、將因此不能耕種。』

『翰得生知在印度興得之長年灌溉區域、以鹽類累積之故、而變爲不肥、有云、如問及每英畝之出產量、則據多數耕者之事實、自水渠開成以後、皆大爲減少。加拉其之官長繆兒氏亦曰、由渠水之作用、引起心土中鹽類之移動、其極可駭異之例證、可見於加苛巴。如提及在早七十年之加苛巴、則此種變化、極爲顯著。其時在兵營一帶、土地佳良、水質不鹼、菜園特別繁茂、而此地所生各種菜蔬、每種皆有如極佳之英倫產者。現則全區皆成鹼地、水井多無用、而菜園亦消滅。』

『滿氏在尼那流域之鹼土觀察、表示出在五年之極好收穫以後、約有五千英畝之地、已多少轉成瘦瘠、此現象、示波及之區域、仍在增加。此在引用渠水灌溉以前、尚不知在此區域中、有鹽類之結皮也。灌溉在印度農業、極爲重要。因之、以印度之大規模之新式灌溉工事之發展、鹼土之整個問題、在農業上、必須注意。』（在民國九年至十年之間在二萬一千二百萬英畝中、有四千九百萬英畝施行灌溉、其中有二千三百萬英畝之水、來自渠中、上文據Proceeding Rome. Conference, 1924, II. p5. 646—648)

印度較老之灌溉法、爲自幹渠及支渠放水至田中、渠之水面則高於所灌溉之田。以此種方法、使耕者易於用過多之水量。故後來之方法、則使幹渠及支渠、低於田面一公尺以上。使農人須用龍骨車或戽水筧乃能昇水至田中。此種方法、所用之人工固多、但農人則因之能獲作物應需之水量而不致費用過多之量、可自然防止水之濫費、而減少滲入心土中之水量。此則可消減潛水面之上昇、鹼質昇高之害。

赫爾葛氏、昔時土壤學界之聞人也、約在三十年前、由發生於加里弗尼亞州之嚴重結果、極力主張、若不在排水上、同時有適宜之設備、以使將來之過多潛水流出所灌溉之區域、應不建築灌溉渠道。距今數年前、潘德頓在台灣見一顯著之實例、爲信此種諍言、作一大規模之灌溉設計、以使用於約八二〇〇〇公畝之地。其地之一部、已有傾近鹼地之勢。此種計劃爲用以灌溉及用以排水之二者、皆同時建築。此爲防止鹼質增加之特別原因、蓋鹼質之隨潛水而上昇、爲必不可免者也。

由以上諸例、似無煩申述須極小心以防止薩拉齊土壤中潛水面之昇高、以使此平原中之土壤免去災害。至關於此事件之排水方法已溢出此文之外、但似乎極宜於使所有支渠及幹渠之尾部、皆通通鑿開、以使支渠中水得自由流出、以防止在未完工之渠道末端有儲集之水。如此則將大減滲入土中之水量、且可同時防止支渠尾部之泛溢。

又在現有支渠下部各渠間、必須有排水渠道之設備。且必須引入黃河、以防止潛水上昇。其認此種排水設備、最好展緩至潛水果眞昇高之時者實爲不智。在其他區域、已屢次證明只須表面土壤、曾一度受過度鹽類之侵染、則雖用水或化學方法以去此過量之鹽類以使土還至出產有利時皆非經濟可行之道。此在土壤

中之過量鹽類、似將永久妨害其在農業上之用也。

反對者自然將以爲現尙無金錢與熱誠以完成現有之支渠、更無以建設任何排水計畫。但以深層土含鹽若此之多、而單行灌溉「其成效若何、將終有使吾等洞明究竟之一日也」「其所趨結果之不利、吾等實深鑒之也。」又在灌溉區域中、其農業將來之危險、如能避免須多避免、因所借給該縣之大借款之償還、全仗土地之生產力及灌溉區域中、耕者水錢之付給也。

氣候

綏遠之氣候乾燥、雨量極低、夏季溫凉、而冬季極冷。此如竺可楨(註五)先生所云爲屬於可本氏之草原態、此在中國包有熱河察哈爾及滿州之西部、全年平均雨量爲二〇—四〇公分、而平均溫度則爲五—一〇度。

註(五)竺可楨—中國氣候區域論、中央研究院氣候研究所集刊第一號。

關於本地氣候韓憲章(註六)君有云在五月至九月間、僅有一五〇日之平均溫度在十五度以上。但其時之夜間溫度、仍低於日間數度、因此、在秋季無農作物可以生長、而僅有春季作物也。自民國四年至十八年綏遠農事試驗場所記之每月平均溫度及雨量如下表:

註(六)韓憲章—綏遠的農業、二十年七月一五—二三日天津大公報。

	一月	二月	三月	四月	五月	六月	七月	八月	九月	十月	十一月	十二月
攝氏溫度	一一·七	七·〇三	一·三	八·三	一五·六	二一·〇	二四·四	二一·八	一五·八	九·八	一一·〇	一九·七

雨量公厘	五	九	七	五	二〇	六三	九七	一〇二	七六	二二	四	六

自民國四年至十八年之全年平均雨量爲三八八公厘。但在此十五年中之任何一月、其最高之平均數、皆不過一〇二公厘、如農事試驗場表中所記者。

全年平均雨量亦分配不均、在民國八年、十年、十四及十五年、雨量之變化、爲四七三—八八〇公厘。在十六年極爲乾旱、全年僅有三五公厘之雨量。在十七年則爲五〇公厘、但在是年之四月五月、八月則完全無雨。在六月僅一・五公厘、爲是年之大饑饉之所由來也。是時約有百分之八十之人民（綏遠共一五三八八一九人、除少數灌溉能及之區域而外）皆成難民。人民受災最烈之區爲薩拉齊及托克托。

關於風暴、無一定之記錄、據云、在春季之末、風常害及種子幼芽及果樹、有時全株之種子、亦吹出地面、果樹之花亦被摧殘。

摘要

一　此文報告綏遠薩拉齊區土壤調查之結束。

本區地形有三種顯明之形勢、（一）陡峭山地（二）坡斜之冲積扇形地（三）黃河之冲積平原。

綏遠系之土壤、在平原中、薩拉齊系之土壤在扇形地上。山地以太陡而崎嶇、無可耕之地在本區東部扇形地及平原間、有極小之泥炭累積區域。

又於以下之土區有詳細之敘述；綏遠粉砂壤土、極細砂壤土、及粘壤土。薩拉齊細砂壤、砂壤、礫質砂壤、壤

土及粉砂壤。及討子號有機質土壤之次要土組。

所有土壤皆爲未熟土、大多數示有極高之炭酸鈣合量。所有粘土、在本區中、非由風化而生、而多爲黃河所帶入。

本區農業、以受雨量稀少之限制、非常退化。有重大之饑荒、較諸華中各地、每家農地皆較大、係自二至一二五公畝。除經營極佳而有長期之溪流灌溉之小果樹區而外、地價皆極低。

灌溉用人工所及之井水及山谷溪流、又有一大新式灌水渠道正在建築中爲給水於綏遠系土壤之大部之用。

大多數之土壤標本、其能溶鹽類之分析、表示鹽量之高度足以預告此種土壤在大規模灌溉上之危險並指示將有麻煩隨之而生、除非緊守灌溉上之極端謹愼方法也。

氣候極乾燥而冷、約有三八八公厘之平均雨量、但各年變化、極爲不同。大多數之雨、皆降於六月及九月之間。溫度在十五度上之日數、約爲一五〇日。

SOIL BULLETIN

Number 4 May 1932

SOIL SURVEY OF THE SALACHI AREA, SUIYUAN PROVINCE, CHINA

By

Robert L. Pendleton, L. C. Ch'ang, W. Chen & K. C. Hou

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SOIL SURVEY OF THE SALACHI AREA SUIYUAN PROVINCE, CHINA.

by

ROBERT L. PENDLETON, L. C. CH'ANG, W. CHEN, & K. C. HOU.

INTRODUCTION.

The purpose of a soil survey of a region is to give an idea of the soils, and their distribution, relative importance, and the relationships of these, to the agricultural characteristics and direction of agricultural development of the region.

This report contains a portion of the data collected in the course of a hasty reconnaissance survey of the region during the month of June, 1931, at the time of the formal opening of the Salachi-Toketo Irrigation Canal (薩托民生渠). Field work at this time gave an excellent opportunity to observe many kilometers of relatively freshly exposed soil profiles which were of great interest. Over one hundred photographs were taken of soil and agricultural subjects, from which there have been selected and presented with this report 16 illustrations of some of the more conspicuous soil and topographic features. The large collection of soil samples made in connection with this study has not yet been extensively studied in the Laboratory, because of the insufficiency of suitable apparatus. Additional reports on this material may be expected later.

This study has been made possible by the grant of the China Foundation to the National Geological Survey for the Soil Survey. The field work was greatly facilitated by the engineering staff of the China International Famine Relief Committee, who placed at our services quarters and transportation facilities.

DESCRIPTION OF THE AREA

This area is located in Suiyuan Province (綏遠省), a portion of Inner Mongolia (內蒙古) and west of Kueihua city (歸化城), and just east of Paotou (包頭). Longitude 110° 20' - 111° East, Latitude 40° 20' - 40' North. The Area extends about 40 km north and south and about 80 km east and west. The area is roughly triangular in shape, lying between the Yin Shan (陰山) on the north, the Huang Ho (黃河) on the southwest, and the Hsihaitzŭ (西海子) and the Hê Ho (黑河) on the east.

The topography is very marked. The steep mountains to the north rise hundreds of meters up very steeply from the plain (See Figures 11, 16). Extending out from their foot are the series of alluvial fans, making a zone of from 2 to 9 km wide (See Figures 11,13 - 16). The remainder of the area is occupied by the almost perfectly flat and level recent alluvial plain of the Huang Ho. This plain, however, is marked by the old river channels (See Figure 2), which meander over the plain. The elevation above the sea level are from 989 to 995 meters. Kueihua station (歸化站) to the eastward is 1,045 meters.

The regional drainage is very distinct. There are the short steep mountain gorges, emptying out onto the plain, building up the alluvial fans (Figures 13, 14). And there is the main river to the southwest. For the most part the mountain streams disappear on the plains, leaving no lakes or channels out to the main river. But to the east where the soils are heavier and the distance to the river farther, there is the intermittent lake Hsihaitzŭ and coming into the area from the northeast is the Hê Ho which at some seasons carried water on out to the Huang Ho near Toketo (托克托).

The population is made up of a few of the older Mongol tribes, and a larger number of Chinese who have immigrated from the east and southeast. But due to the very low rainfall and the serious famines there have been enormous losses of inhabitants by death and emigration. Ninety five percent of the population are said to be farmers, and most of them to have come from Shansi (山西省). Other occupations are coal mining, alkali salt leaching and commerce. The population of Salachi hsien (薩拉齊縣), which is approximately of the same extent as the Salachi area, in 1929, was 45,000 families, or about 330,000 people. This equals about 2 persons per square li or 8 people per square kilometer.

The transportation of the region is dependent principally upon the main line of the Peiping-Suiyuan Railway (平綏鐵路), which runs thru the northern part of the area, and on west to Paotou, which is about 10 km west of the western edge of the area. The Huang Ho is also of importance in the transportation of some commodities. Local transportation is mostly by cart on the plain, while donkeys and camels are used for bringing coal out of the mountains for local consumption and for shipping.

There are no good roads or highways within the area. There exist some cart tracks and earth roads suitable for light motor cars, aud which may be used during the most of the year.

The principal market of the area is Salachi hsien (薩拉齊縣). Paotou to the west of the Area, and Toketo to the southeast are also of importance. Kueihua (歸化) is an important center, tho located about 100 km to the east along the railway.

NATURE OF SOIL MAPS AND REPORTS

Definition of terms: Texture—the coarseness or fineness of the soil mass; the combined or mass effect of the different sizes and quantities of individual grains or particles making up the soil".

Structure—a term expressing the arrangement of the individual grains and aggregates that make up the soil mass. The structure may refer to the natural arrangement of the soil when in place and undisturbed or to the soil at any degree of disturbance."

Soil Profile—the vertical section of the soil from the surface to the underlying unweathered material."

Soil series—a group of soils having the same character of profile—(the same range in color, structure, consistence, and the same sequence of horizons and degree of horizontal development) the same general conditions of relief and drainage and usually a common or similar mode of formation. A group of soil types closely similar in all respects except the texture of the surface soils."

Soil type—A soil which throughout the full extent of its occurrence has relatively uniform texture of the surface soil and relatively uniform profile characteristics. The unit of soil mapping.

The basis of the soil mapping and of this report are the data which have been collected in the course of field work, during which time many observations were made of exposed cuts, many soil borings made, photographs taken, and information collected from the local residents.

The limitations of time and the scarcity of rapid transportation facilities very considerably limited the work, and for that reason the distribution of soil types has been shown in two ways on the map, by solid colors and by lines of the same color. The solid colors indicate the portions of the area that have been studied in some detail by one or more members of the party, while the lined portions are the regions that have not been visited but which the conditions indicate will have soils of the sort shown.

The base map used for this survey is the 1:100,000 military map of the Government. In places it is very good, but the lack of astronomic or trigonometric control is shown in the layout of the lateral canals on the map. These lines as surveyed on the ground, are actually straight and parallel, but when placed on this base map, to maintain the correct positions with respect to the local villages, the lines have been shown as crooked, and not all the same distance apart. It is thus apparent that the villages are not correctly placed in many cases. There are also certain inaccuracies in the shape of the lower slopes of the mountains, as near Meitachao (麥達召). In this survey it has not been found practicable to correct these errors by making a new base map.

GENERAL SOIL DESCRIPTION.

The soils as a whole belong to four groups, (1) the extensive alluvial plains of the Huang Ho, (2) the narrow band of alluvial fans along the base of the mountains, (3) the very small bodies of organic matter soils near Taotzuhao (討子號) and (4) the very thin and very steep residual soils of the steep mountains.

The soil materials that compose the alluvial plains are undoubtedly largely loess from far up the Huang Ho (Yellow River), and transported great distances. The amount of material that has come from stream erosion of materials harder than loess in the headwaters of the Huang Ho is probably very small if not almost lacking entirely. The alluvial fans are made up of the rock fragments due to the erosion and weathering of the Yin Shan mountains, undoubtedly mixed with some loessal material, tho there is not much evidence of such material, for the latter is probably almost entirely washed on out to the level plain, and there is lost by mixing with the similar alluvium from the main river.

The material found in the course of boring the deep well on the "Modern Farm" (新農試驗場) about 9 km east of Salachi indicates, according to Barbour (personal communication), that the recent geological history of this region indicates a satisfactory agreement with that of the neighboring parts of China that have been studied. The provisional correlation is as follows: the 8 meter (25 feet) layer of loess-like material is similar to Malan material, the material deeper being Sanmenian and Pliocene. There are altogether 55 meters (185 feet) of sediments, the bottom 12 meters (40 feet) being of black mud.

Barbour further states that the peat deposits are believed to be a relic of early post-Pleistocene times, when there was a change of climate, between the time of the Malan and today. There is evidence elsewhere to show that with this climatic change extensive regrading of stream washed areas took place with distribution of loess-torrential material. These peat deposits, lying under soil material, and more or less influencing the surface soil material, make up the Taotzuhao series of soils. In some places there seems also to be a relation between these deposits and present day springs and depressions, causing the accumulation of more organic matter, or at least providing sufficient moisture to retard the decomposition of the material in the arid climate. These deposits for the most part are located along the edge of the alluvial fans, and in slight depressions, where springs would be expected.

The mountains are so steep that there is not much chance for soil materials to accumulate. Where there is soil, it is undoubtedly a mixture of purely residual material with some aeolian deposits. Chemical weathering processes are very slow because of the very arid conditions that prevail.

The vegetation of the region is very scant, as would be expected in a steppe region. The main cultivated plants are found on the alluvial fans and the plains, with a greater development on the lower portions of the fans and certain portions of the plains. Goats and fuel and timber gatherers leave few trees on the mountains.

THE SOILS OF THE AREA.

The soil series that is by far the most extensive in the area is the Suiyuan, comprising the broad alluvial plain of the Huang Ho. The series of the alluvial fan soils is the Salachi. And that of the small bodies of organic matter soils is the Taotzuhao.

The *Suiyuan series:* The soils of this series are a light grayish brown, medium grayish brown, to at times a brownish gray field color. The colors when moist are slightly browner. The textures of the surface soils of the types found in this region vary from a very fine sandy loam, or a silt loam to a clay loam, comprising the sizes of particles that can be transported by a relatively slowly flowing stream. The materials have been deposited in very recent geologic times by the Huang Ho, which has meandered over the whole plain. The old stream channels

are still distinctly visible in many places (See Figure 2), and the more prominent ones are shown on the soil map. The alluvial deposits being recent, and the chemical weathering processes very slow in this region, there is no developmental profile, tho there are very extensive and rapid variations in the nature of the particular depositional layers or strata, due to the rapid shifting of the river which deposited the material. The most characteristic differences are shown in the silt loam type, where there are frequent and repeated changes from a clean light grayish brown silt to a reddish brown clay (See Figures 4 - 9). Due to the low rainfall there is a considerable amount of soluble salts in the profile (See Figures 4 and 5 and Table 2). Usually however, without excessive water the concentration of salts at the surface are not great enough to prevent crop growth. All the soils are calcareous. The soils of this series cover over 86% of the non-mountainous portion of the area.

The *Salachi series* is a group of soils comprising the alluvial fan deposits along the southern slope of the Yin Shan mountains. These soils occupy a zone from one to nine kilometers wide. They compose about 13% of the arable soils of the area.

The soils as a whole are a light grayish brown, a light brown, brown, to a dark brown in the field, becoming as a whole browner when moistened, tho in a few cases when moistened the color become much darker.

In texture the soils of this series vary from a gravelly sandy loam, thru a sandy loam, and a loam to a fine sandy loam or a silt loam. There are all gradations in greater or less amount, including such phases as small amounts of redeposited loess, stony washes, etc. Naturally the coarser materials lie closer to the streams and the mouths of the canyons, and the fine sandy loam farther away, on the gentler slopes, sometimes a number of kilometers from the mouth of the canyon (See Figures 13 - 15).

The soil profile is very variable, often being largely of gravels and sands, cross bedded and intermixed with finer materials. Due to the building up of the fans at the present time, and to the relative slowness of the weathering processes in the region, because of the low temperature and aridity, there is however no indication at all of a developmental profile thru weathering processes (Neither elluviation nor illuviation). In no case are there found lime concretions in the upper meter of the soils, tho these soils often effervesce strongly with hydrochloric acid.

Due to the location of these soils, their exposure to erosion, and the porous nature of the deeper materials, the ground water level at times is very far below the surface, 20 to 25 meters (65 to 80 feet), on the upper slopes, and the soils are often too stony for satisfactory use, unless the stones are gathered and removed from the fields. Yet it is this very location at the mouths of the valleys and the porous nature of the materials, which provides abundant ground water around the lower edges of the fans, and makes possible the irrigation of wheat, poppies[1] and other crops on the fine sandy loam and sandy loam types of the series around the edges of the fans, as at Salachi town. In other words, despite the general difficulty of handling the soils of this series, the most intensive agriculture and valuable crops are produced almost entirely on soils of this series. There is also the unusual development of intensive fruit culture as at Shuitsingkoumen (水晶溝門 Figs. 10 - 15) at the mouth of the valley north of Salachi, due to the heavier soils there, and the relatively abundant supply of irrigation water from this larger canon. Because of these characteristics, the favorably located soils are as much as 50 times as valuable in terms of sale price as the average soils on the plains.

The crops grown without irrigation are sorghum, beans, millet, and sweet potatoes.

There is great danger of the streams shifting their courses and flooding land that is under cultivation. This has in places been guarded against by building stone walls. And the soils have also been built up artificially by the making of terraces, and leading onto the terraces the rapidly flowing muddy water, thus letting the sediment accumulate.

There had been found no hardpan and no lime or other concretions in the profiles of this series.

Taotzuhao Series. The soils of this series are a bluish or dark bluish gray silt loam on the surface. There is considerable organic matter, both decomposed

1. It is of course understood that the cultivation of opium poppies and the collection of the opium is prohibited by law, and it is hoped that in the future its cultivation will be discontinued, because of the terrible consequences of the popular use of opium. However, at the time of making the soil survey the crop was tacitly recognised by the local government and taxed heavily. Moreover, the crop occupied such an important place in the agriculture of the area that it could not be ignored. Also, a serious consideration of this intensive crop shows the possibilities of special crops; and other special crops that can grow under similar conditions are very much needed in the region, to provide a crop that can be profitably sold and exported to the centers of consumption.

and undecomposed, in the soil. There is more organic matter in the subsoil than in the surface soil. The real deposits of "peat" which are used for fuel in the winter, occur over a meter below the surface. The profile of one such excavation is as follows:

0--120 cm gravelly silt loam to light silt loam
120—150 ,, Deep grayish black silt loam
150—210 ,, "Peat" black, mottled with yellow.
210—downward. Deep grayish black silt loam, gravelly sandy loam, etc.
See samples 25, 26.

These accumulations of organic matter seem to be located in connection with springs which occur in this region on the lower portions of the alluvial fans. Elsewhere has been given Barbour's explanation of their occurrence.

In this area the soils of this series are very minor in quantity, covering about 0.03% of the total area. There are much larger bodies to the east, outside of the Salachi Area. The bodies that are labeled "peat" on the geological map of the region are probably all of this soil group. It seems probable, judging by the size of the bodies that we say, that the bodies on the geological map are somewhat exaggerated in size.

There are small bodies in Timenkêng (鐵門更), Hsiatalai (下達賴) and Taoerhao (討兒號) villages. Some of the soils are planted to crops, for the peat material itself is far below the surface.

DESCRIPTIONS OF THE SOIL TYPES.

Suiyuan silt loam. The color is a light grayish brown, or occasionally a light brownish gray in the field; a light brown when moist.

The texture is a silt loam to light silt loam, 20—40 cm deep, less often 60 cm, and occasionally as much as 1 meter deep. In places lighter in texture to almost a clean silt.

The subsoil is a light brown or occasionally a light brownish gray color when dry; a silt. The variation in thickness and arrangement of the silt, the clay loam, or the very fine sand of the lower layers is very irregular, as long sections of the freshly excavated canal show. Borings also show wide variations tho the general character of the materials is very uniform. The clay loam strata are made more of a reddish brown.

Formation: The whole mass of the material has very obviously been laid down by the Huang Ho, and has been carried from long distances, hence the uniformity of materials, tho local sorting in the profile is conspicuous. Figs. 4-8.

The topography is almost if not entirely flat for considerable distances, with occasional stream channels, which are usually associated with lighter phases of the type or with the very fine sandy loam type. Fig. 2.

The age of this type is very young, showing no differentiation in the profile due to the weathering or the translocation of the material downward.

This soil is undoubtedly a fairly good soil, when free or reasonably so from soluble salts, "alkali", and when reasonably well drained, tho this soil often gives the impression of being a very poor soil. It often stands uncultivated, because of the alkali (Figs. 1,3), at other times because it is owned by Mongols, and these people are apparently not so inclined to cultivate their lands. They prefer to use the land for pasture. At other times the soil is idle because there are not the people to cultivate the land.

The crops raised are wheat, oats, millet, sorghum, hemp, flax (for seed), soy beans, etc., all the typical lowland crops, with the exception of opium, which seems to be confined almost exclusively to the slightly lighter soils of the Salachi series, where there is also found a better underground water supply.

This type is by far the most abundant of the whole district, occupying the major portion 76% of the land on the plain proper (from Tengkou (鄧口) to Toketo), and extending nearly to the mountains on the north.

There is a light phase of this soil that blows badly, it is about 25-30 km ESE from Salachi, beyond Maotacheng (毛倍鎮) (Profile 91) [1]. At Weichun (爲俊) 3 km NW from Salachi is a deep deposit of silt loam which is interbedded with sandy loam and underlain by other material that has come from the hills to the north (Profile 86). The soils slightly more reddish brown on the terrace about 1 m lower, about 25 km S of West of Salachi, south of Kungchung (公中) village are apparently wetter because of the lower elevation, and the constant capillary rise of water from the ground water level, bringing much salt to the surface (Fig. 1). This soil for the most part cannot be cultivated, but is used

1. These Profiles refer to the original profile field notes, made on the basis of borings, excavations or exposures. These notes are on file in the office of the soil survey.

for pasture (profile 72). Profile 69 and the photo (Fig. 6) of the auto on the top of the unexcavated portion of the canal show excellently the great variations in the deposition of the material, and the cross bedding effects of the rapid stream flow. Some salts are efflorescing on the surface of the heavier strata. There is some alkali refining about 1/3 km north of Ershihszuchingti (二十四頃地) town wall. Figs. 4,5.

In a number of places the drainage of this soil is poor.

In some places where the clay loam and the silt loam are near together, as Profile 51, near Taipalakai (大巴拉蓋), the clay loam has much better crops than the silt loam, perhaps because of the more moisture.

On the Salachi—Toketo Road the soil as a whole is either light silt loam, silt loam, or a clay loam, with much of the silt loam and clay loam showing evidences of salt content. At the time of the survey the concentration did not appear to be serious in most of the soils. In places where the silt loam surface soil had been removed, or the subsoil exposed thru stream action, as near Shuanglungcheng (雙龍鎮) the silt underlying blows badly, filling the air with dust. This was even the case where there had been a recent shower. At the end of June, 1931, the crops were still unplanted or at least had not yet come up to any considerable extent. As a whole the country gives one the impression of being poor. This is due to the depopulated villages, the ruined buildings, the heaps of dung in the roads and paths, and the much uncultivated land. Certainly part of the land is too salty to cultivate, and there are too few people to cultivate all the land that is reasonably free from salt. Moreover, doubtless the rainfall was inadequate for the season, up to the time of making the survey.

Around Kangfangyingtzu (缸房營子) 30 km east of Salachi we saw very little real alkali or saline soils, with practically no crusts to indicate serious amounts of salts; there were almost no typical alkali weeds. North from this village, nearer the railway there is some leaching of the surface soil for the recovery of salts, and there is some vegetation indicating an excess of salts. The priest in charge of Kanfangyingtzu reported that only about two thirds of the lands of the village could be farmed, because of "alkali." But we feel that at times at least the effects ascribed to the excess of salts are due to a physical condition of the soil, rather than a chemical one.

About 19 km south of east of Salachi, in the excavations for the check gate for lateral No. 9 (See Figure 9), from about 1.8 meter downwards to over 2.8

meters there was found a dark gray clay loam (Samples 3 and 4, Profile 66). This soil is evidently a "fossil" soil, one which formed the surface soil previous to the present deposits of the Huang Ho. This indicates an earlier, lower plain with a relatively mature soil. It seems likely that this is the same, older soil formation that is visible on the surface north of the "Modern Village" (新村) about 10 km east of Salachi.

Suiyuan very fine sandy loam. The soil is a very light brownish gray in the field, and a light grayish brown when moist. The texture varies from a very fine sandy loam to a light silt loam. The surface soil is from 20 to 40 cm deep, lying on a clay loam or a silt. Sometimes there are alternating layers of silt and clay loam or clay.

This type is a result of deposition from slightly more rapidly moving water, and is consequently found mostly close by the old stream channels. Usually there are no sharp boundaries between this type and the silt loam type. In this survey there was no attempt made to carefully separate this type from the silt loam, as it was impossible to do it within the limitations of the survey. There are scattered bodies of this type in many places south and southeast of Salachi. As mapped, this type occupies about 3% of the non-mountainous part of the area.

The crops are millet, patatoes, and legumes. In places, the drainage is poor, Less fertile and lower value than the Suiyuan silt loam.

Suiyuan clay loam. The color of this soil is a light grayish brown to medium or dark grayish brown, or at times a brownish gray in the field; it is a little browner when moist. The texture of the surface soil is a clay loam; this horizon is from 10 to 40 cm or more deep, lying on a silt loam or a clay loam subsoil. The subsoil is more yellowish, pinkish, or darker in color. This horizon may in turn lie on a very fine sand, silt, or clay. There exist wide variations because of the varying conditions that prevailed during deposition from the streams. Rarely if ever have the horizon distinctions been caused by weathering since deposition. As a whole the topography is flat, the soil often occupying slight depressions. Consequently the drainage is poor.

This soil is planted to yumei or millet, but very often not cultivated at all. The reasons for less cultivation are the poorer drainage; the greater amount of salts on the surface probably caused by the standing water; and also because of the heavier texture and the greater difficulty in cultivating it.

The soils of this type are located in scattered spots, one about 28 km east of Salachi, near Kanfangyingtzu, another about 20 km west of Salachi; alkalin, cheap, useless. The largest body, which is very extensive, is located from 50 to 65 km southeast of Salachi, near Toketo. As mapped, this type occupies about 7% of the non-mountainous part of the area.

About 4 to 5 km southeast of Taotzuhao railway station (陶思浩站) there in the northern portion of the Hsihaitzu there are transitions between the silt loam around the edges of the lake and the clay loam that occupies more of the bed of the intermittent lake (Profiles 83, 84). This soil is a light gray to gray color in the field, a dark gray when moist, and the structure is peculiarly coarsely granular down to about 40 cm. Below that it is a brown to dark brownish gray clay loam (moist color). The drainage is of course here very poor, and the soil is used mostly for pasture; a part of it however is heavily diked and farmed. Sometimes there are transitional form of this type, where the coarser material is carried out onto this type from the Salachi series to the north (Profile 82).

Salachi fine sandy loam. These are soils with a variable color, from a light grayish brown to light brownish gray in the field; a light brown to medium brown when moist. The texture is a fine sandy loam, occasionally inclining to a loam or sandy loam. The depth of the surface soil is variable, from 30 to 70 cm or more.

The subsoil varies from a sandy loam to a light fine sandy loam, to a loam, or a silt loam; deeper the material may be underlain by gravels—these are typical variations within short distances, as would be expected of a stream deposit from rapid water. And the origin of this material is just that, of stream deposits on the edges of the alluvial fans, tho at times wind action has assisted in separating this finer material from the coarser. There is no other profile development, as the soil is distinctly young, often even now being built up by further stream or wind action. The soil effervesces with hydrochloric acid, indicating abundant carbonates. As mapped, this type occupies about 5% of the non-mountainous part of the area.

Of crops, opium is the most important one from the standpoint of value per unit area. Other garden crops and wheat are also grown on this type. The porous substrata and the good ground water supply, usually at shallow depths, makes this type very suitable for opium or garden crops.

The topography is that of slight elevations, or nearly flat. A large body of this soil is located at Salachi, others are associated with the margins of the alluvial fan deposits, as at Hsiatuhochi (下土合气) and east around Meitachao (麥達召) etc.

Tho the soil is "light" it is used for the walls of houses and for village walls and for sun dried bricks!

In places there are lenses of gravel close below the surface which seriously reduce the water supply to the plant roots, causing the crops to wither and die early in the season, unless the crops are irrigated. To the west, near Taituhochi (大土合气) near the outer edge of the Salachi fine sandy loam in the bottom of the main irrigation canal, at about 4 meters from the surface are heavy gravel layers, with a deep yellowish brown rust color, apparently due to iron carried in the ground water, which is abundant here, causing trouble in excavation. Lime concretions are also found, cementing the sand and gravel.

As a whole this type is free from excessive quantities of soluble salts. In one place it was reported (profile 76) by the villagers that there was some salt at about 1 to 2 meters below the surface of the soil.

The crops are millet, wheat, and vegetables. Wheat is said to yield 8 to 9 tou (斗) per mow (7,650 to 8,650 kg per hectar). A fair yield of millet is considered to be 3 to 4 tou per mow (2,900 to 3,800 kg per hectar), while a good yield is considered to be 8 to 9 tou per mow (7,650 to 8,650 kg per Ha). The value of this land is said to be about $65 per mow ($1,000 per hectar).[1]

Salachi sandy loam. The color of this type is a light brown, brownish gray, to a dark brownish gray when moist; it is usually a light grayish brown when dry. In one case a fresh profile exposed on a ditch bank moistened by the rain showed to one meter depth a very dark gray color thruout. The texture is a sandy loam, varying from a fine sandy loam to a coarse sandy loam. Sometimes the wind has blown finer material into dunes of fine sand, leaving coarser material as the sandy loam. There is a considerable contamination with potsherds, clinker, broken brick, etc. This is probably the result of carrying village wastes out onto the fields with the fertilizers. The depth of the surface soil is about 30 cm.

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1. All values are stated in local dollars, which at the time were approximately the half of the mexican dollars of the rest of China.

The subsoil is sometimes uniform for a meter or more, and continuous with the surface; sometimes the lower material is a silt loam, a fine sandy loam, or there are gravel beds and lenses of this material. Sometimes these extensive gravel beds just below the surface seriously affect the crops during the dry weather.

The topography of the surface varies from slight elevations to nearly flat bodies, or in places the surface is considerably affected and dissected by shallow stream channels; or the surface may be the gentle slope of the alluvial fan surfaces. There are located considerable bodies of this type north of Salachi railway station and on to the hills, as well as other bodies east of the east gate of Salachi. There are additional bodies about Taotzuho. This type occupies about 4% of the non-mountainous part of the area.

All the soils are very young, with no signs of profile development, except in the deeper layers, where several meters below the surface there is some lime cementing.

The crops are sorghum, poppy, beans, millet, potatoes. When irrigated the wheat is said to produce about 1 tan per mow (1,000 kg per Ha). The value of this land where it can not be irrigated is from $7 to $16 per mow ($100-250 per ha); where irrigated it is from $20 to $40 per mow (Local dollars) ($320-$640 per ha).

Salachi gravelly sandy loam. The color is a light grayish brown in the field, a medium grayish brown when moist. The texture is quite variable within very short distances, as would be expected on alluvial fans with rapid stream flow, and quickly shifting currents affected by artificially diking fields to keep off wash, and by picking off stones from fields. In places the soil is a stony loam, in others a gravelly loam, and in still others a sandy loam with more or less gravel. The depth of the soil is considerable, but the nature of the underlying material is very variable. In places the gravelly sandy loam has been washed out over the older heavier darker soils.

The crops are millet, sorghum, potatoes, soy and other beans. There are large areas that are not planted, since the soils yield poorly, and as they are often stony, they are hard to cultivate. There is also the frequent danger of damage to the crops by erosion by the torrential outflows from the canons.

These soils occupy large expanses of alluvial fans along the southern slopes of the Yinshan mountains. The soils are typically developed northeast of

Salachi about 6 to 10 km. See Figures 13-15. The total area of this type is about 3% of the non-mountainous part of the area.

Salachi loam. This soil is a medium grayish brown in the field, and a dark grayish brown when moist. The texture is a loam, with a depth of from 30 to 40 cm, lying on a brown very fine sand. The topography is flat. This soil is located in only one small body, northwest west of Salachi, near Panshihchi village (板什气). This type occupies about 0.25% of the non-mountainous part of the area. The main crop is yumei, and it was doing well.

Salachi silt loam. This soil has the usual grayish brown color when moist, and is in texture a silt loam with transitions to a sand and a gravelly sandy loam. The topography is that of a gentle slope. The one body of this soil is located about 4 km north-east of Salachi Railway station (薩拉齊站). It is a very minor type, of about 0.1% of the lowland area. The soil is planted largely to Irish potatoes and wheat.

River wash. This is the term that is used for the gravel and coarse sandy washes occupying the beds of the mountain torrents. The material for the most part is of no value agriculturally, because of its texture, apart from the danger of damage by freshets. This group covers about 0.4% of the non-mountainous portion of the area.

Rough Mountainous land. This is the designation of the material composing the surface of the mountains. In places there is considerable soil, but for the most parts the slope of the mountains is so steep, and the soil so shallow or entirely non-existent, that it is of no importance at all for agriculture. See figures 11 and 16.

TABLE 1.

Areas of the several soil types

Type	Area					
	Surveyed		Estimated		Total	
	Hectares	%	Hectares	%	Hectares	%
Salachi G.S.L.	4,733	2.36	2,188	1.09	6,921	3.45
Salachi F.S.L.	7,519	3.75	3,386	1.69	10,901	5.44
Salachi loam	515	.26	—	—	515	.26
Salachi Si. L.	178	.09	—	—	178	.09
Salachi S. L.	7,059	3.51	970	.48	8,030	3.99
Suiyuan C. L.	3,426	1.70	10,485	5.23	13,911	6.93
SuiyuanV.F.S.L.	1,743	.87	4,415	2.15	6,158	3.02
Suiyuan Si. L.	47,941	23.89	105,108	52.39	153,050	76.28
Taotzuhao soil	59	.03	—	—	59	.03
River wash	861	.43	—	—	860	.43
Total	74,034	36.89	126,554	63.03	200,584	99.92

AGRICULTURE

The agriculture of this area is extremely poorly developed, primarily because of the insufficient rainfall, and the consequent arid steppe conditions. The famine conditions and the lawlessness that have prevailed have also greatly retarded the agricultural development. That inadequate rainfall is the main limiting factor, seems to be substantiated by the relatively advanced state of the agriculture in the one well-irrigated fruit district in the area, located north of Salachi. Of course where the Mongols control the land, the emphasis is upon stock raising rather than on cultivation of the soil, and this is a factor which has some bearing on the present state of the agriculture of the region. The ably managed villages belonging to the Catholic Church and which are located out in the plain are not nearly as prosperous as they should be if the rainfall were less deficient. These villages have relatively good defences and consequently superior relative security and other advantages.

The land values for the area vary from less than a dollar a mow to more than $70 ($10—1,000 per ha). The most of the land varies between $3 and $25 per mow ($50 to $400 per ha).

The size of the farms varies from 30 mow to over 2,000 mow (2 ha to 125 ha).

The main crops are millet, sorghum, yumei, buckwheat, wheat, soy and other beans, linseed, peanuts, hemp, and Irish potatoes. On the Salachi series of soils one of the very important crops in point of value is the opium poppy*, tho in area it is greatly surpassed by the usual field crops. With increased irrigation and more people, there is an abundant opportunity to increase the agricultural production. At present much of the land stands idle. The proportion of land devoted to vegetable or truck crops is very small, tho water melons are said to do very well, and are shipped from the area.

The field crops are planted between April and June, depending upon the rainfall, and are harvested in September. Poppies and garden crops can of course be planted independent of the rains for they are grown on land that is usually irrigated by wells. After planting the seed beds are rolled with stone rollers to compact the soil and induce the rise of moisture by capillarity and so hasten germination.

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* See footnote, Page 7.

Livestock is limited mainly to draft and pack animals, with some sheep and goats. There should be an increasing place for draft animals with the increase of irrigation, and the extension of the cultivated area. Moreover, with the removal of the water as the limiting factor, there will be a greater use for farm yard manure. This, at present is scarcely used, except on the poppies or truck crops, or for fuel. The land as a whole is so poor in organic matter that with water there should be great response of all the field crops to manure.

Doubtless the use of green manures in the fall, and plowing them under before the winter freezes the soil, will be a beneficial practice, when Huang Ho water is available in the autumn on the plains from the canal. At present this practice of green manure is impossible. It is not likely that for a long time there will be any use of commercial fertilizers, unless for opium or other special crops. Nitrogen, however, would probably give very good results at times. It is understood that there is to be no poppies grown on land that is to be irrigated by the Salachi-Toketo Canal.

Opium culture is carried on very extensively on the Salachi series of soils, tho it was found to be difficult to obtain exact information about the cultivation or production of the crop. Every plot is said to be irrigated every 7 or 8 days if the water supply be adequate. It requires the full time of four men to cultivate and tend 2 mow (30 men per Ha). The crop is fertilized with 2 to 3 carts of manure per mow (20 to 30 carts per Ha). All kinds of manure are used, tho it seems to be mostly night soil, hauled out in cart casks, and put into masonry pits to ripen near the wells, and then dipped into the irrigating ditches and so carried over the fields with the water. In collecting the juice of the poppies, there are a great many collections of the stuff, going over the field every day. This requires a large amount of labor. A tax of $40 per mow ($300 per Ha) is said to be charged by the local government.

Irrigation. At the present time there are four methods of irrigating the soils of this area: (1) the use of well water. This is confined mainly to the Salachi series of soils, where the water is relatively close to the surface, and it is free from excessive amounts of dissolved salts. (2) The use of ditches to carry the flood waters from the mountain torrents out over the Salachi soils and out onto the edge of the Suiyuan series of plains soils. (3) The irrigation of fruit and garden crops by the continuous flow of springs or stream water from a few of the larger gorges of the Yinshan Mountains. And (4) along the eastern edge

of the area are regulation works on the Taihêho (大黑河) that provide irrigation along that stream. And now there is to be the addition of a fifth sort, in the use of the continuous flow of the Huang Ho in the Salachi-Toketo irrigation project. The use of the water of this river is not new in this Province, for farther up the river there are extensive canal systems that are at present delivering the water to the land. Unfortunately it was not practicable this past season to make a personal study of the irrigation methods and results in the region west of Paotou, but this should be done when possible, for there are undoubtedly many points of value to be learned there which can be applied to the soils of the Salachi area.

The water of the Huang Ho (Yellow River) at the canal intake altho appearing very yellowish brown with the mud, according to measurements by the engineer of the C. I. F. R. Commission in the Summers of 1930 and 1931 carries only about 2 percent of silt and clay in suspension. This is a very great contrast to places farther down the river, where many times this amount have been found.

EXCESSIVE SALT CONTENT OF THE SOILS.

Attention has already been called to the relatively high content of soluble salts in the soils of the Suiyuan series, and as to the difficulties that these salts already cause in the production of crops. In this connection there must not be overlooked the fact that all the soils of the Suiyuan series have a very considerable salt content thruout the soil profile. (See table 2 for the analyses of the samples for soluble salts).[1] These salts thus present a very serious potential danger to the successful cultivation of crops under irrigation in this region. This means 86% of the soils of the entire area included within this soil survey area.

From the analyses of the soils (Table 2) and the nature of the soil profiles that have been exposed in the freshly excavated canal banks, it is apparent that the salt is present thruout the entire soil mass. (See Figures 4, 5, 8). But with the light rainfall of the region, there is usually not enough soil moisture to fully dissolve these salts and enable them to move very far in the soil. This is the main reason why there is not more of an accumulation of soluble salts or "alkali" on the surface of the Suiyuan series of soils.

1. Analyses by Mr. K. C. Hou.

TABLE 2

Alkali Salt Content of the Soils of Salachi Area.

Soil Sample No.	Soil Type	Depth, cm.	Location	Total Salts[a] pp m	Chlorides pp m	Sulfates pp m	Carbonates pp m	Bicarbonates pp m
1	Suiyúan Silt loam	0-20	Houchia-yingtzu. (侯家營子)	1,565	65	144	54	1,035
2	,,	25-45	,,	761	87	210	25	764
3	,,	180-200	Lateral 9 (民生渠第九支渠)	895	90	144	25	663
4	,,	210-250	,,	715	100	121	20	651
5	,,	270-285	,,	925	115	171	36	633
6	,,	0-20	Wangtafa-yingtzu. (王大發營子)	1,152	288	137	25	606
7	,,	25-50	,,	1,314	298	530	38	782
8	,,	0-30	Wuszŭ-chitui (鄔氏圪堆)	1,934	530	943	26	414
9	,,	35-50	,,	1,434	146	295	40	502
10	,,	(surface crust)	Pataku (八大股)	35,150	10,250	15,012	0	373
11	,,	0-20	Bridge 2	2,860	572	599	66	1,084
12	,,	25-50	,,	668	90	99	18	500
13	Suiyuan Clay loam	0-20	,,	3,912	793	1,434	25	514
14	,,	30-50	,,	1,107	212	383	20	636
15	Suiyuan Silt loam	0 25	Taouteh (大磯兌)	1,152	71	80	22	543
16	,,	30-60	,,	695	92	103	16	509
17	,,	0-22	Tsitsomaoan (七座毛庵)	1,025	71	119	12	622
18	,,	30-50	,,	585	65	156	18	568
19[1]	Salachi fine Sandy loam.	0-25	Siaochang-kulu. (小廠圖圖)	3,730	1,575	1,510	18	623
20	,,	30-55	,,	690	140	189	14	568
21	Salachi Sandy loam.	0-30	Siaoyang-chang. (小羊廠)	666	81	140	25	646
22	,,	40-60	,,	480	135	177	23	474
23	Suiyuan Clay loam.	0-20	Taotzuhao St. (陶思浩站)	2,540	1,520	469	23	815
24	,,	25-35	,,	780	240	202	25	869
25	Taotzuhao Silt loam.	0-50	Timenkèng (鐵門更)	845	125	197	20	703
26	,,	110-150	,,	850	230	156	28	681
27	Salachi Loam.	0-35	Panshihchi (板什气)	900	145	263	23	396
28	,,	40-60	,,	565	85	206	7	283
29	,,	0-20	,,	39,300	17,225	13,907	0	251
30	Suiyuan Silt loam	0-10	Hemapan (黑嘛板)	6,735	2,675	2,191	10	394
31	,,	20-40	,,	810	165	177	17	409
32	,,	(surface crust)	,,	43,090	14,050	20,293	0	436
33	Salachi Gravelly sandy loam	0-2)	Tatolinching (大斗林沁)	405	25	115	15	296
34	,,	25-50	,,	375	70	111	0	358
35	Suiyuan Clay loam	0-20	Kungchipan (公吉板)	7,530	1,825	3,012	1	501
36	,,	25-50	,,	1,290	200	374	23	658

1. Leaving a moderate quantity of red ppt. on standing for a period of four months.

2. The total amount of soluble salts including cations; this is in fact unreliable, c. f. U..S. D. A; Division of Soils. Bull. No. 18, p. 69.

In the region of the boundary between the Suiyuan and Salachi series of soils, where from the mountain torrents there has been an additional amount of water in the soil, and over the surface, and particularly where this additional water has flowed onto and into the heavier types of Suiyuan soils, as the clay loam, or the silt loam, there has been some ponding of the water at times, and in addition there has been enough water in the soil to be drawn up from considerable distances by capillarity. This water has dissolved and brought with it the salt from the deeper portions of the soil profile, and has left the salt on the surface of the soil as whitish crusts. Thus are developed the particularly infertile patches that have been used only for pasture or for the leaching of salts for washing or cooking purposes. Fig. 3.

Since thus far the total annual amount of water that has gotten onto or into the soil has been very small, and consequently the possible accumulation of soluble salts or "alkali" at the surface of the soil is very small. But with the advent of the extensive irrigation system, with abundant water during the whole ice free season of the year, the dangers from this source will be very real and very great.

An abundant supply of water in the soil, which will almost certainly result soon after the commencement of use of the big Salachi-Toketo irrigation system, will dissolve all the salt in the soil. The constant seeping out of the water from the canals and laterals thru the porous soil material, will certainly very soon raise the water table in the entire region up to about that of the level of the water in the canals. Then the continuous evaporation of the water from the surface of the soil will leave a constantly increasing amount of salt on the surface of the soil, and the few hundredths or a tenth of a per cent of salt that now is found in every foot of the soil down for a number of meters, will finally all be accumulated at the surface of the soil, and the result will be that there will be no profitable crop plants which will be able to grow in such a soil. Thus it may easily be that the abundant irrigation water in the end will be a curse rather than a blessing.

ALKALI OR EXCESS SALT DAMAGE IN OTHER COUNTRIES.

That this prediction of the almost certain ultimate unfavorable effect of extensive irrigation is no idle fancy, below are given the opinions of specialists and some illustrations of what has happened in other arid regions, in widely

scattered parts of the world, where large quantities of irrigation water have been applied to soils.

Lyon and Buckman state "Altho these salts are in part carried down again by the next irrigation, the upward movement constantly exceeds the downward one. There are large areas of land in Egypt, India, Hungary, France, Italy, and the United States that have suffered in this way, and not infrequently they have reverted to an infertile condition". (Nature and Properties of Soils. Rev. Ed. Page 282, 3).

In Fresno county, California, I have visited a district of about 20,000 acres which previously, during the early years of the irrigation of the region, had been a thriving and prosperous fruit growing district. The water table was then 20 meters or more below the surface of the ground. Irrigation and seepage from the irrigation canals, without adequate provision for drainage of excess subsoil water gradually raised the water table until when I was there the water stood practically at the surface of the ground, and the fruit trees had been practically all killed by the combined effects of the excessive water in the soil and the accumulation of the salts at the surface. The farmers had been ruined financially and the farm houses deserted.

A similar story may be told of other of the irrigation projects, in other arid parts of the United States. One of the leading American authorities on alkali soils from the practical agricultural point of view, Harris, of Utah, in his book "Soil Alkali" says as to the selection and evaluation of arid soils: "On the other hand a soil may show very little surface indication of alkali; it may contain a good growth of certain kinds of vegetation; yet an analysis might show that at some distance below the surface there is a layer of soil that is highly charged with salts. This land would only need to be brought under cultivation and irrigation to make the subsoil alkali a real source of danger. "....."Soils are frequently found containing a medium quantity of salt distributed thru considerable depth. With the introduction of irrigation and a consequent raising of the water table to within a few feet of the surface, an ideal condition is provided for the concentration of these diffused salts at the surface. This may render entirely unproductive a soil that previously raised good crops. A thoro knowledge of the ground water conditions is, therefore, important before a person is able to make an intelligent judgment regarding alkali land." pp. 242, 243.

In India there have been some very unfortunate experiences with the "rise of the alkali" and the consequent permanent injury to soils, following irrigation particularly from extensive canal systems. Professor Gangulee, in a report to the 4th International Conference of Soil Science, Rome, 1924, states the matter very clearly: "One of the discouraging features of extending cultivation in alkali regions is that, altho it essentially depends upon irrigation, its introduction appears to disturb the equilibrium of the underground water level causing the "rise of the alkali". The Irrigation Department of the Northwest Provinces observed this troublesome phenomenon" and in 1876 a special commission was appointed. This commission reported that alkali "is generally found to occur in those parts where the cultivation depends upon irrigation and also where the natural surface drainage is bad or has in any way been interfered with by an obstruction like a railway embankment....."Under the ancient systems of agriculture in India there was very little increase in the amount of soluble salts at the surface, but with the construction of large modern canals and the application of unnecessarily large quantities of irrigation water the increase in alkali was very rapid."

"Hall pointed out before the Indian Alkali Soils commission that "irrigation by canal water when not accompanied by deep drainage, has had the effect of increasing the amount of alkali deposit and large tracts have been in consequence thrown out of cultivation."

"Henderson finds that the areas under perennial irrigation in Sindh [India] are becoming unfertile due to alkali deposits, and writes "if the yield per acre be inquired into, it will be found, according to the evidence of a large number of cultivators, to be very greatly reduced, since the opening of the canal." Mules, Collector [magistrate] of Karachi, writes "A very striking instance of the movement of subsoil salt induced by the action of irrigation channels or floods is to be seen at Jacobabad. For one who remembers Jacobabad in the early seventies the change is very remarkable. Then the land in the cantonments was sweet, the wells were sweet, and the water good, the gardens were remarkable for their luxuriant growth and the vegetables raised therein were every bit as good as the best English vegetables. Now the whole place is salt, the wells are many of them useless, and the gardens have died away."

"Mann's investigations in the salt lands of the Nira Valley show that after yielding, as was expected excellent harvests for a period of five years, about 5,000 acres were rendered more or less completely barren; and the indications

are that the effected area is increasing. Previous to the introduction of canal irrigation, the presence of salt incrustations was unknown in this tract. Irrigation is one of the most important factors in Indian Agriculture and therefore with the extension of modern perennial irrigation works in India, the whole problem of alkali soils must receive due attention from the agricultural investigators of India. (In 1920-21, out of the total cultivated area of 212 million acres, 49 million acres were under irrigation, about 23 million acres of which received the water supply from the canals.)" (Proceedings Rome Conference, 1924, II, pp. 646, 648).

The earlier irrigation systems of India were designed to deliver water to the fields by gravity flow from canals and laterals with a water level at a higher level than that of the fields to be irrigated. But as this made it too easy for the cultivators to use much more water than the crops really needed, later systems were designed with the canals and laterals having a water level as much as a meter or more below the field level. This necessitated the farmers pumping or elevating the water by chain pumps or swing baskets up onto the fields. The total labor involved in this process is enormous, but the farmers are able to get the water needed for the crops, but will not use more than they absolutely need, thus automatically preventing the wasteful use of water and so decreasing the seepage into the subsoil from the irrigated fields. This minimizes the rise of the water table and reduces the amount of damage from the rise of alkali salts.

Hilgard, one of the outstanding leaders of soil science in his generation, on the basis of the serious conditions that had developed in California, nearly 30 years ago strongly urged that no irrigation system should be constructed without at the same time making adequate provision by a drainage system for the removal of any possible future excess of subsoil water from the tract to be irrigated. A few years ago in Formosa I saw a striking example of this advice being followed in the construction of an immense irrigation project to serve about 82,000 hectars. A part of the area served was inclined to be somewhat alkaline. The plans of the system were for both an irrigation and an extensive drainage system, both of which were being built simultaneously. This was for the very specific purposes of preventing the increase of unfavorable alkali conditions which would inevitably follow a rise in the water table.

With these examples it would seem hardly necessary to further labor the point that the greatest precautions should be taken to prevent the rise of the subsoil water in the soils of the Salachi region, and thus avoid the otherwise

practically certain serious damage, if not total ruination, of the most of the soils of the plain for cultivated crops. The engineering features of any such drainage system for this purpose are beyond the scope of this note, but it would seem very desireable to have all the laterals and the end of the main canal cut clear thru, so that there may be from the laterals a free flow of the tail water, and thus to prevent the ponding at the ends of any otherwise unfinished channels. This would greatly reduce the amount of water seeping into the soil, and at the same time prevent the otherwise almost certain overflow onto the surrounding lands about the ends of the laterals.

Provision should also be made for the construction of drainage canals between at least the lower ends of the present laterals. These should lead out into the Yellow River, and so prevent the rise of the ground water to a dangerous degree. This may seem an entirely foolish recommendation at the present time, as it may be thought better to postpone such drain construction until the water actually rises. But experience in other parts of the world has repeatedly shown that once the surface soil has become impregnated with an excess of soluble salts, that there is no economically practicable way, either by the use of water or chemicals, of removing the excess salts and getting the soil back into a condition that it will produce profitable crops. The excess of salts once in the soil seems to more or less permanently damage it for further agricultural use.

The objection will of course be made that there is at the present time neither the money nor the enthusiasm necessary for the completion of the present laterals; much less for the construction of any drainage ditches. This must not, however, blind us to the practically inevitable outcome of the irrigation of these soils which contain so much soluble salt distributed thru the deep soil. This danger that faces the future of the agriculture of the irrigated soils of the region is all the more to be avoided if possible, since the repayment of the large loans that have been made to the district depend upon the productivity of the land and the consequent possibility of the payment of the annual water rent by the cultivators to the irrigation district.

CLIMATE

The climate of Suiyuan is distinctly arid characterized by a very low rainfall, a cool summer, and a very cold winter. This is characterized by Coching

Chu (竺可楨) [1] as belonging to Koppen's steppe type, which in this part of China includes also Jehol (熱河) and Chahar (察哈爾) and the western part of Manchuria, having a mean annual rainfall of 20-40 cm and a mean annual temperature of 5° to 10°C.

Han [2] Footnote says of the climate: "There are only about 150 days between May and September that have a daily temperature of more than 15°C. Even during that time the temperature at night is several degrees less than in the daytime. For this reason no crops can be grown in the fall, and consequently only spring crops are available for cultivation. The monthly means of daily temperature and rainfall for 1915-1929 recorded by the Suiyuan Provincial Experiment Station may be quoted:

	Temperature °C	Rain-fall mm		Temperature °C	Rain-fall mm
January	—11.7	5	July	24.4	97
February	— 7.03	9	August	21.8	102
March	1.3	7	Sept.	15.8	76
April	8.3	5	Oct.	9.8	21
May	15.6	20	Nov.	—1.0	4
June	21.0	63	Dec.	—9.7	6

The average annual rainfall from 1915-1929 is 388 mm. The highest average rainfall in any one month within these 15 years has not exceeded 102 mm. This is shown in the table from the Experiment Station.

The annual rainfall has also fluctuated in a very irregular manner. In 1919, 1921, 1925, and 1926 the rainfall varied between 478 and 880 mm. In 1927 there was a severe drouth with the total rainfall for the year only 35 mm. In 1928 the total was 50 mm, but in April, May, and August there was practically no rain, and in June but 1.5 mm, a great famine resulted. Nearly 80% of the total population (of 1,538,819 people of Suiyuan, except for a few irrigated districts), became refugees. The localities where the inhabitants suffered the most were Salachi and Toketo.

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1. Memoir of the National Research Institute of Meteorology, No. 1. Climatic provinces of China by Coching Chu. Nanking, 1931. National Research Institute of Meteorology, Academia Sinica, Pei-chi-ko, Nanking.

2. T. C. Han (韓憲章), The Agriculture of Suiyuan (綏遠的農業). Ta Kung Pao, Tientsin, July 15-23, 1931.

As to winds there are no definite records. It is said that in late spring the wind frequently injures the young grain seedlings and the fruit trees. Sometimes the whole grain plant are blow out of the ground, and the blossoms of the fruit trees are destroyed.

SUMMARY

A report is submitted of a survey of the soils of the Salachi Area, Suiyuan Province, China.

The topography of the area has three outstanding features: (1) steep mountains, (2) sloping alluvial fans, and (3) the flat alluvial plain of the Huang Ho.

The Suiyuan series of soils are on the plains, and the Salachi series on the fans. The mountains are too steep and rugged to have enough arable soil to map. There are very small bodies of organic deposits, "peat", near the junction of the fans and the plain, in the northeastern part of the area.

Detailed descriptions of the following soil types are given: Suiyuan silt loam, very fine sandy loam, and clay loam; Salachi fine sandy loam, sandy loam, gravelly sandy loam, loam, and silt loam; also the minor group of Taotzuhao organic soils.

The soils are all very immature, showing for the most part a high content of calcium carbonate. The clay that is present has not been developed in the area by weathering, but for the most part been carried into the area by the Huang Ho.

The agriculture of the area is very backward, being severely limited by the scant precipitation. Famines have been serious. Compared with Central China, the size of farms is large, ranging from 2 to 125 hectars. The land values are very low, except in small highly developed fruit districts enjoying continuous irrigation from mountain streams.

Irrigation has been carried on with manually raised well water, and from the flow from mountain streams. A very large modern irrigation system is now under construction to supply water to most of the Suiyuan series of soils.

Analyses of a large number of soil samples for their water soluble salt content show this to be sufficiently high to constitute a clear warning of the dangers involved in any extensive irrigation of the soils, and an indication of the certain trouble that may follow unless the most careful methods of irrigation are observed.

The climate is very arid, and cold, with an average rainfall of about 388 mm, tho this varies very greatly from year to year. Most of the rain falls between June and September. For about 150 days the temperature rises above 15°C.

EXPLANATION OF PLATE I.

Fig. 1. Suiyuan silt loam. This location is southwest of Kungchung (公中) village, not far from the Huang Ho, which is at the back of the camera. There is a large body of these soils on a lower level than the main plain to the north, and because the water table is not quite so low, i. e. closer to the surface of the ground there has been an accumulation of soluble salts in the surface soil, hence this land is used mostly for pasture. The soil is considered poor. It is feared that unless adequate drainage is provided in the irrigation district, that after the canals are in operation that this condition will develop very generally thruout the district. 24 km. south of west of Salachi. No. 15-7.

圖一　綏遠粉砂壤地在公中西南距黃河不遠黃河即在照相鏡之後有大區之此種土壤在低於北部平原之處因潛水不面低接近於地面故在表面有能溶鹽類之聚積故多用作牧草場土壤頗瘠若非適宜水道在灌溉區內備好則在水渠使用之後此種情形將普及全區爲可憂也薩拉齊西南二四公里

Fig. 2. Suiyuan silt loam and very fine sandy loam. These two types make up a very large expanse of country, thru which old river channels meander. This is a view across one of these channels, near Shuanglungcheng village (雙龍嶺). The soil is a very fine sandy loam, and it blows badly. The car is partly down the slope of the old channel. In the depression the soil is moister and beyond at the reader's right of the figure is a small pond in the bottom of the depression. 40 km. east southeast from Salachi. No. 18-11.

圖二　綏遠砂粉壤及極細砂壤此二土類伸佈之極大區域爲舊河道之所流經此爲此諸河道中之一景在雙龍鎮附近土壤爲極細砂壤易被風吹起汽車在將下舊河道之斜坡上在此低地中土壤較爲潤濕在圖之左方爲此低地中之一小池在薩拉齊東南東四〇公里

Fig. 1.

Fig. 2.

EXPLANATION OF PLATE II.

Fig. 3. Suiyuan silt loam, where as a result of poor drainage, much alkali has accumulated in the surface soil, it is not used for agriculture, but only for pasture. The surface crusts are scraped up, and leached with water in special basins about a meter in diameter. The leachate is then evaporated to a concentrated solution, and the salts crystallize. This photo was taken about a kilometer south of Kungchipan railway station (公吉板站), and about 13 km. west of Salachi. No. 18-4.

圖三　綏遠砂粉壤土以排水不良之結果有多量之鹼質聚集於土壤之表面未以爲農作之用僅用以爲牧草場製鹽之法爲括起表面之結皮在直徑約一公尺之坑中以水滲洗之乃蒸發此濾出之水成濃溶液則鹽類結晶析出此片攝於公吉板車站南約一公里薩拉齊西一三公里之處

Fig. 4. The soil profile of the Suiyuan silt loam as exposed on lateral No. 9. This shows the alternating layers of silt loam and clay loam, with a slight amount of alkali efflorescence on the older, darker soil exposed near the bottom of the excavation. Near Taihouchiayingtzu (大侯家營子) village, about 22 km. east southeast of Salachi. No. 13-9

圖四　露出於九號支渠之綏遠粉砂壤土之土層此示粉砂壤土及粘壤土之互層在露出於接近底部之較老而較暗色之土壤上有少許鹼質華斑地在大侯家營子附近約在薩拉齊東南東二二公里

Fig. 3.

Fig. 4.

EXPLANATION OF PLATE III.

Fig. 5. A portion of the bank of lateral No. 6, in Suiyuan silt loam showing the large amount of alkali efflorescence, not only at the edges of the darker, heavier, and deeper clay layer, but also quite generally over the surface of the exposure. Since this section shown is of a total depth between A & B of not over about 2 meters, with the filling of the lateral, and the consequent rise of the water table all this alkali is likely to rise to the surface and accumulate there. Near Kaotsaichuyingtzu (高蔡車營子) village. About 5 km. east of south from Salachi. No. 14-6.

圖五　六號支渠渠岸之一部在綏遠粉砂壤中此多量之鹼質華斑不獨在較暗色較粘重而較深之粘土層之邊上有之且在露出之剖面上亦極爲普遍因此剖面示表土心土二層之總厚不過二公尺故以支渠之灌水而昇高潛水面此鹼質亦似將昇至地面而聚集在高蔡車營子附近約在薩拉齊東南五公里

Fig. 6. A section of the Suiyuan silt loam along lateral 8 at Ershihszuchingti (二十四頃地) village. In spite of the shovel marks there may be seen the bedding planes and the slight tendency to cross bedding. Variations in texture are also apparent. About 20 km. southeast from Salachi town. No. 13-10

圖六　在二十四頃地沿八號支渠之粉砂壤土剖面其上雖有鏟痕而層面及所帶之交錯形式皆可看出質地之變化亦清楚約在薩拉齊東南二〇公里

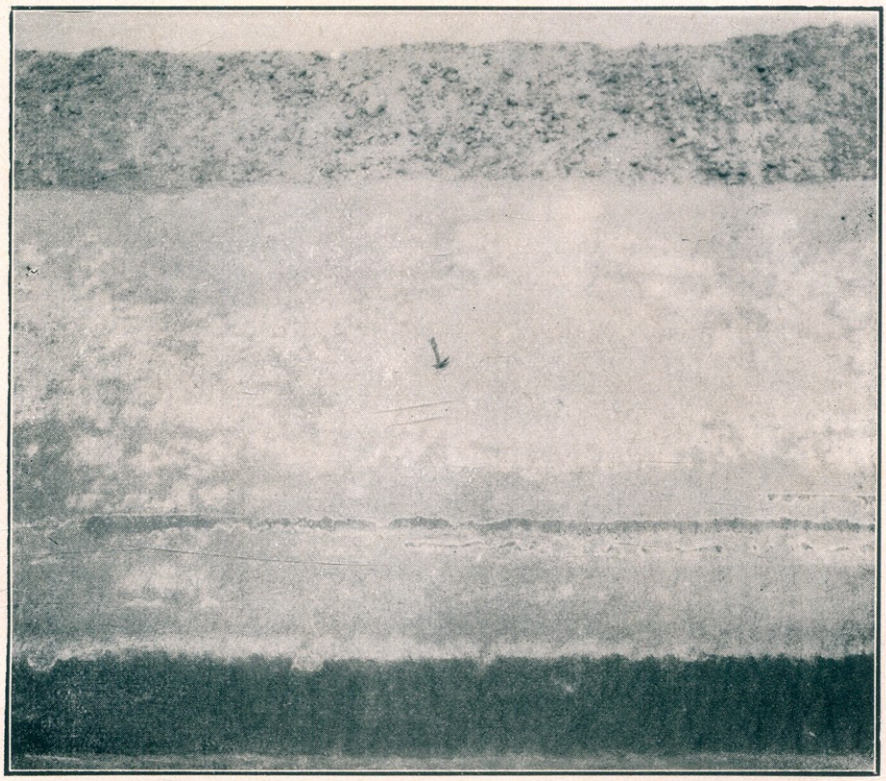

Fig. 5.

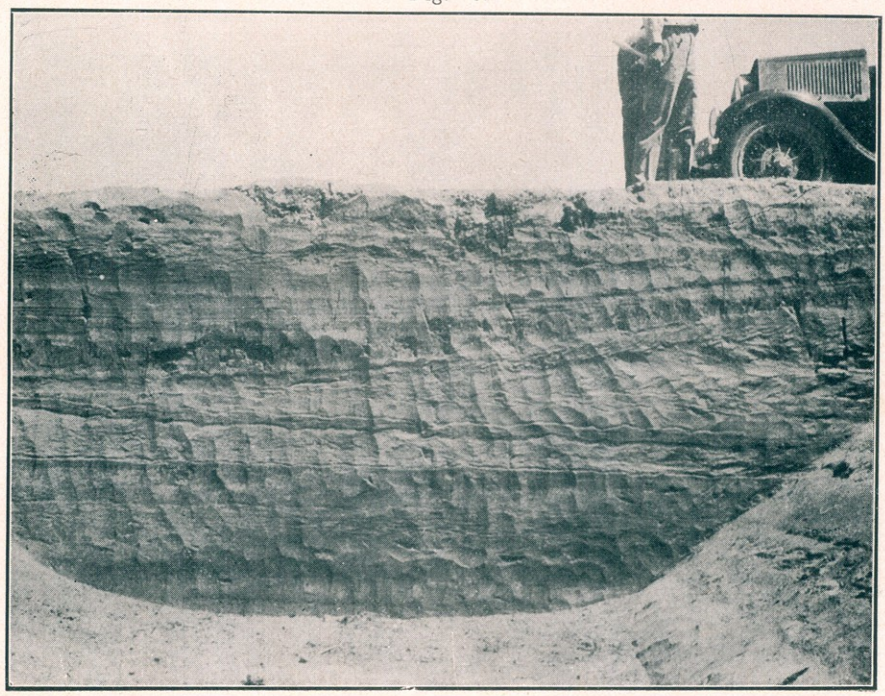

Fig. 6.

EXPLANATION OF PLATE IV.

Fig. 7. The upper portion of the profile of the Suiyuan silt loam exposed in a newly dug well at Szutsomoan village (四庵毛座). The differences in texture are clearly shown between the silt loam and the clay loam, the latter being darker in color, and cracking slightly. (See also figure 10. About 21 km. south of east from Salachi town). No. 13-6.

圖七　在四座毛庵一新掘井中露出之綏遠粉砂壤土層之上部粉砂壤土與粘土層之不同表示極明後者色較暗而稍坼裂(參看圖一〇)約在薩拉齊東南二一公里

Fig. 8. The lower portion of the soil profile exposed in the well shown in Fig. 7. The upper thin clay layers are apparent, as are also the deeper, thicker, and moister clay layers, at the upper portion of which, particularly, there is visible the white alkali efflorescense. This is at a depth of 1.9± meters, and would very easily be brought to the surface with a rise of the water table. No. 13-7

圖八　在圖七之井中所露出土層之下部上部之粘土層及較下之厚粘土層皆極清楚特在下層上部有可見之白色鹼質華斑深度約爲一八公尺必極易於爲昇高之潛水面帶至地面也

Fig. 7.

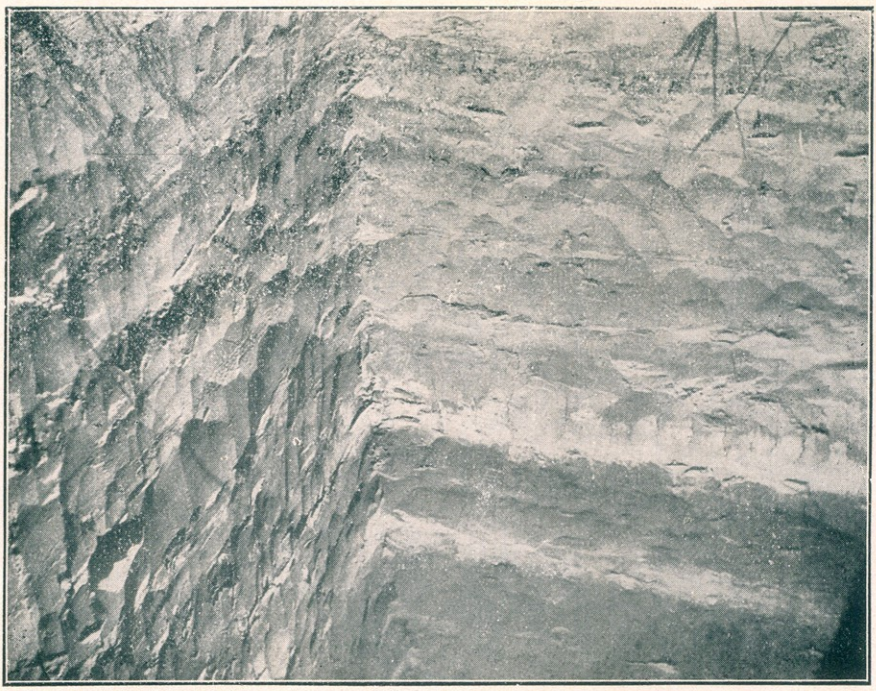

Fig. 8.

EXPLANATION OF PLATE V.

Fig. 9. A section thru the Suiyuan silt loam and lower layers at the foundation excavation at lateral 9 near Houchiayingtzu village (侯家營子). The surface is silt loam, but behind the central portion of the auger, and in the deeper excavation there are clay loams. The lower clay loam is of darker material, and would seem to be an older surface soil, before the later deposits were made by the river. About 18 km. east southeast from Salachi town. No. 13-4

圖九　接近侯家營子在九號支渠橋基坑中綏遠粉砂壤及更下土層之剖面表面爲粉砂壤土但在鐵鑽中部之後面處及較深之處爲粘壤土較下之粘壤爲較暗色之物質當爲昔時之表土也約在薩拉齊東南東一八公里

Fig. 10. Orcharding and gardening combined on Salachi sandy loam in Shuitsingkoumen (水晶溝門) about 6 km. north from Salachi town. Apricots and other fruit trees are visible, as are the irrigation channels from tree to tree. A variety of vegetable crops are grown beneath the trees. The "orchards" are really gardens; each surrounded by a high stone or earth wall; frequently the cultivator lives in a house within the enclosure. No. 16-8

圖一〇　在薩拉齊砂壤上之果園雜菜園之景約在薩拉齊北六公里有杏及其他果樹渠水皆夾樹而流菜蔬則種在樹下此果園蓋眞爲園也皆圍以高石墻或土墻耕者常宅居其中

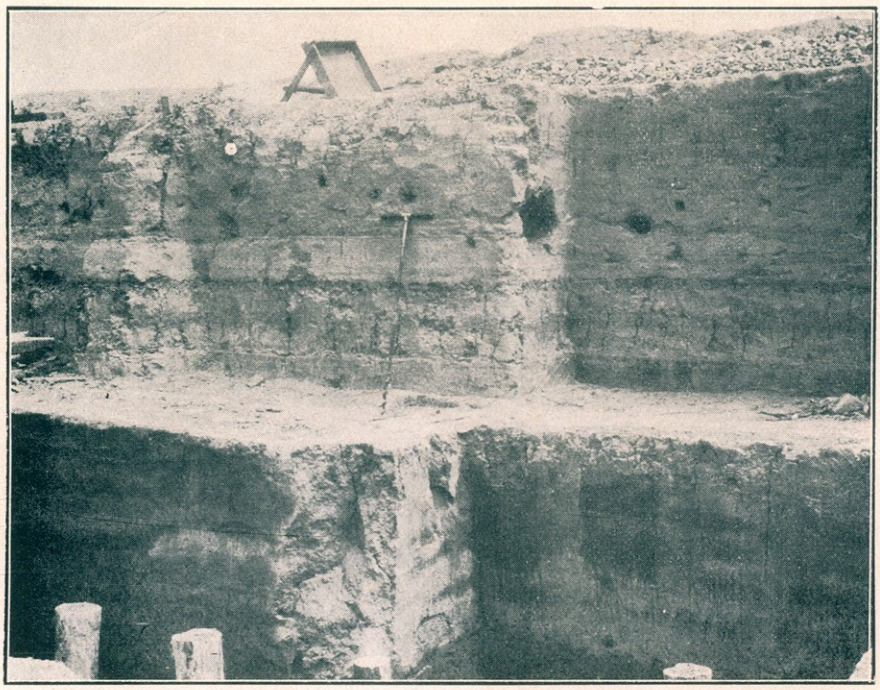

Fig. 9.

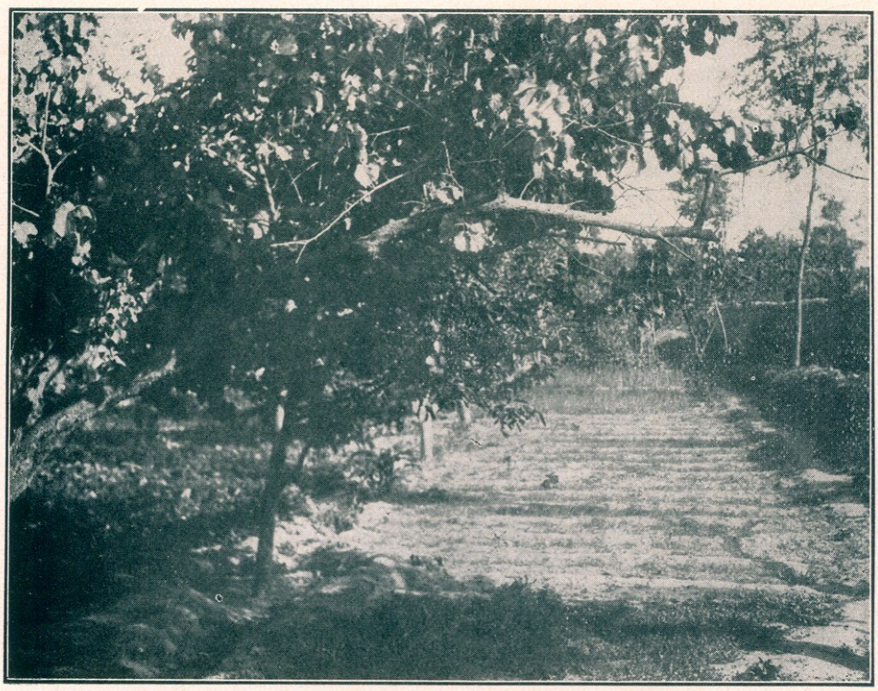

Fig. 10.

EXPLANATION OF PLATE VI.

Fig. 11. The productive Salachi sandy loam at Shuitsingkoumen village (水晶溝門), 6 km. north Salachi town. This is a poppy field. In the background, beyond the higher earth wall is a plantation of fruit and shade trees. This region obtains a considerable amount of irrigation water from the large stream which emerges from the mountains at this place. The soils are quite a mixture of textures, belonging to the Salachi series. No. 16-9.

圖一一　在水晶溝門出產佳良之薩拉齊砂壤在薩拉齊北六公里爲一罌粟地在其背景中高土墻之後爲果樹及遮蔭樹此區灌溉大宗水源得自山中流出之大溪此種土壤之質地極爲混雜屬於薩拉齊系

Fig. 12. Shuitsingkoumen (水晶溝門). A village path, irrigating ditch and stone wall protecting the orchards and gardens. The trees behind the wall are mostly apricots. The soils of this locality are very much mixed in texture, but belong to the Salachi series of alluvial fan deposits. About 6 km. north of Salachi town. No. 16-5.

圖一二　水晶溝門之村路灌水溝及保護果園菜園之石墻墻後之樹多爲杏樹本地土壤之質地極爲混雜屬於冲積扇形地之薩拉齊系約在薩拉齊北六公里

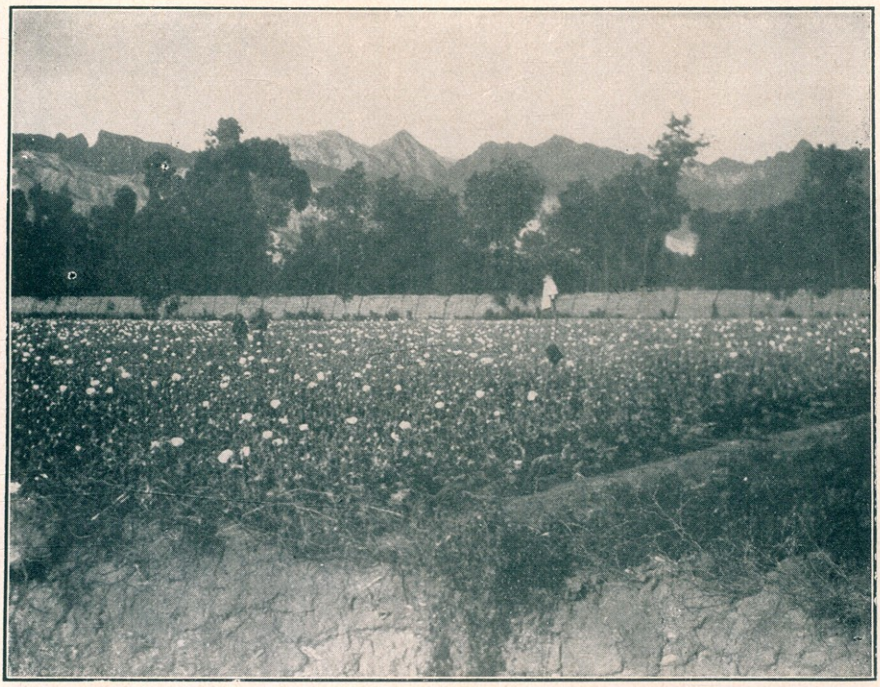

Fig. 11.

Fig. 12.

EXPLANATION OF PLATE VII.

Fig. 13. The plain from the mouth of Atohekou Canyon (阿道亥溝) looking east southeast. This view shows the steep rocky mountain side, the Salachi gravelly sandy loam alluvial fans extending out for nearly a kilometer and not intensively cultivated, and beyond that, in the shadow, the extensive plain, mostly of the Suiyuan silt loam. About 6 km. northwest from Salachi town. (See Fig. 14 for additional views from the same point). No. 17-7

圖一三　向東南東望阿道亥溝口之平原此片示石山之陡峭邊際及薩拉齊礫質砂壤之冲積扇形地此地伸出約一公里而未大耕種又在前部在陰影部分之大平原多爲綏遠粉砂壤土約在薩拉齊西北六公里(同式參看圖一六一八)

Fig. 14. The plain from the mouth of Atohekou Canyon (阿道亥溝). Looking southeast. To the reader's right may be seen the stream wash of coarser gravel and stones; to the left close to the foot of the hill, somewhat protected, are some small patches of irrigated opium. The alluvial fan of the coarser Salachi series extends out for a kilometer or more; beyond which in the shadow are the finer silt loams of the Suiyuan series. About 6 km northwest from Salachi town. (See also Fig. 13 for additional views from this same place). No. 17-8

圖一四　向東南望阿道亥溝谷口之平原在右可見粗石礫及石塊之溪流冲積在左邊接近山脚處其圍護之地爲小區之灌溉罌粟較粗之薩拉齊系之冲積扇形地伸出約一公里或一公里以上在其前之陰影處爲綏遠系之較細粉砂壤約在薩拉齊西北六公里

Fig. 13.

Fig. 14.

EXPLANATION OF PLATE VIII.

Fig. 15. Saerching village (沙爾沁) from above the old temple. The alluvial fan proper or Salachi series of soils does not extend as far as the town wall in the middle distance. In the distance is the extensive plain of the Suiyuan soils. toward Palakai (巴拉蓋) and Salachi. About 23 km. north of west from Salachi town. No. 14-9

圖一五　自古廟上望薩爾沁村此冲積扇形地本身或薩拉齊系並不伸至村外圍墻在遠處向巴拉蓋及薩拉齊爲綏遠系之大平原約在薩拉齊西北二三公里

Fig. 16. Salachi loam, a considerable body, between Hemapan (黑麻板) and Panshihchi villages (板什氣). This type is planted almost entirely to yuma. The long white line at the left is a flock of sheep. Farther in the distance, at the foot of the alluvial fans which lie along the base of the mountains, are the poppy fields, appearing in the photograph as whitish patches. Up on the slopes of the mountains may be seen the remnants of an older terrace, an interesting physiographic feature of the region. About 8 km. from Salachi town. West northwest. No. 17-12

圖十六　在黑麻板及板什氣間之大區薩拉齊壤土此種土類幾全爲植莜麥之用在左邊之白長線爲一羊羣在遠處在冲積扇形地下卽在沿山脚處爲罌粟地在片上爲白色斑點在山坡上可見一舊級形地之遺跡爲本區有趣之地文現象約在薩拉齊西北西八公里

Fig. 15.

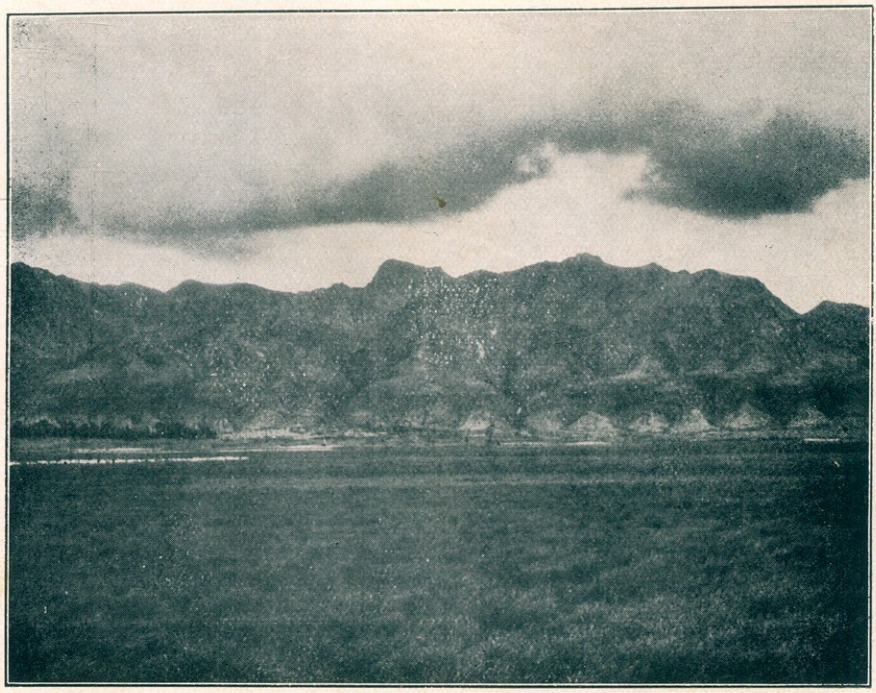

Fig. 16.

薩拉齊區土壤圖

SOIL MAP OF THE SALACHI AREA SUIYUAN PROVINCE CHINA

by
Robert L. Pendleton, L. C. Ch'ang, W. Chen, and K. C. Hou,

1931

Scale 1:150,000

2500 0 2500 5000 M

5 0 5 10 Li

YIN SHAN MOUNTAINS 陰山脈

LEGEND

Svfsl	Suiyuan very fine sandy loam
Ssil	Suiyuan silt loam
Scl	Suiyuan clay loam
Kgl	Salachi gravelly sandy loam
Ksl	Salachi sandy loam
Kfsl	Salachi fine sandy loam
Kl	Salachi loam
Ksil	Salachi silt loam
T	Taotzŭhao soils
Rw	Riverwash
Rm	Rough Mountainous land

SALACHI HSIEN 薩拉齊縣

TOKÊTÔHSIEN

國史館圖書

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Robert L. Pendleton, L. C. Ch'ang, W. Chen & K. C. Hou

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