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THE GEOGRAPHY OF SOUTH AMERICAN RAILWAYS

W. S. Barclay

Continued from page 201. *Map following p.* 320.

CHILE

THE configuration of Chile is unique, not only in South America but in the whole world. The physical factor here dominates all railway construction and a sketch of the main features of the country also roughly outlines the general plan of its land transport. The breadth of the Republic, from the Pacific to its Argentine and Bolivian frontiers, varies from 105 to 248 miles, but its length from Peru through 38° of latitude to Magellan is no less than 2627 miles. Placed across the North Atlantic Ocean, Chile would form a bridge of land joining Quebec to Liverpool, with most of its snow-clad Cordilleras projecting in a continuous line above the ocean. Its surface, running like a ribbon between the Andes and the Pacific, exhibits in this length an extreme diversity, passing from the waterless mineral regions of the north, through the fertile and wheat-growing central provinces, till it reaches broken archipelagoes, the beech-covered hills, and the patches of Patagonian pampa facing the Straits of Magellan.

For its railways as well as for geographical purposes, Chile might hitherto have been divided according to the zones above described, but lately its railway map has undergone a radical alteration. This is due to the construction of the so-called "*Longitudinal railway*," running due north and south, and linking up practically every line in the country with its capital, Santiago, and with its chief port, Valparaiso. Prior to this development, the railways in the desert northern section, from the Peruvian frontier to Valparaiso, were all isolated lines built inland from the coast, with the object of exploiting nitrate and other mineral deposits. In the neighbourhood of Valparaiso an increasing rainfall permits some agriculture, which is supplemented where possible by irrigation from the numerous hill streams. The central zone includes the most populous districts in Chile, together with its chief cities, Valparaiso and Santiago. Here the railways have been constructed as a continuous system, the majority being owned by the State under the name of "*Red Central*" or "Central Network."

Mineral production is still important, since the district embraces the chief coalfields of Chile, with an output of about 1,000,000 tons per annum; but the main livelihood of the population is derived from agriculture, vine-growing, and stock-raising.

The general plan of this central railroad is that of a single trunk-line running south from Santiago to Puerto Montt (facing the Chonos Archipelago in lat. S. 41° 29′), with branches running east up the slopes of the Andes, or west through fertile valleys to sheltered coast ports. In the northern section, where railways are urgently in need of good harbours to handle their heavy nitrate and mineral output, these are conspicuously lacking, and the shippers handle millions of tons of cargo yearly in open roadsteads backed by the coast "barrancas," from piers or landing-stages only slightly protected from the heavy Pacific swell. No one lives in this uncomfortable, arid northern region for choice. As the city man seeks his home in a green suburb after a day's toil amid bricks and mortar, so the Chilean merchant or labourer looks to settle finally in the cool, well-watered, and fertile southern provinces. Nowhere else in South America does just this same distinction exist, and Chileans of all classes are in consequence more used to travel and better acquainted with their own country than is the case with their neighbours.

The last section of Chile, from Puerto Montt southward to Cape Horn, has been and is likely to remain for many years destitute of railways. After it reaches Puerto Montt the valley between the inland and coast Cordilleras drops below sea-level, the coast range is represented by a series of islands, and the main or inland chain is deeply cleft by fjords and rivers. The rainfall in southern Chile is one of the heaviest on the continent, rising to 100 inches per annum, and only exceeded in the Amazon Valley. At present its only railways consist of 96 km. between Ancud and Castro ports on Chiloe Island, and of 8½ km. of an industrial line connecting the lignite mine of Loreto with Punta Arenas (Sandy Point), within the Straits of Magellan. Constructed in 1875 this short Loreto line was, and is likely to remain, the most southerly in the world.

Although the broken aspect of this southernmost zone of Chile has caused it to be thus far avoided by the railway engineer, its study enables us to more readily picture the obstacles confronting his work in the centre and north of the Republic. The coast and inland Cordilleras of the Andes have risen here many thousands of feet, and the intermediate valleys are themselves high above sea-level. In the place of islands we have mountain peaks; isthmuses become lofty ridges; fjords and channels are replaced by transverse valleys with running streams. The great longitudinal valley never entirely disappears, but it varies greatly in aspect. Its average width is about 50 km. (31 miles), but between lats. 33° and 35° the enclosing mountain ranges approach each other so closely as to leave only narrow defiles. This is due to a "Nudo" or knot, characteristic of the Andean Cordilleras, which commences near Cabildo and continues

for some 250 miles north of Santiago, the ranges again separating definitely in lat. 29° S. Once the gorge of the Copiapo River is passed (lat. 27° 20′) the Central Valley runs clear to the frontier of Peru, reaching its maximum width of 100 km. amid waterless nitrate deposits near Antofagasta.

In the central section and even south of Santiago the levels of the longitudinal floor are low and regular, the rise from Puerto Montt to Talca, a distance of 832 km. (515 miles), being only 400 feet. From Talca north levels vary greatly, rising to 1860 feet at Santiago and 4600 feet at Pampa Alta (Antofagasta), with many local and abrupt variations. The rapid changes of level due to the transverse obstacles already noted for years restricted the building of a north and south line, since they obviously entailed very heavy expenses not only for immediate construction but during all subsequent operation.

The Longitudinal Railway.—This great valley traversing the whole length of the inhabited portion of Chile inevitably suggested a continuous north and south railway as the equally dominant factor in the Republic's railway system. Although it has only lately been carried into effect, Chilean statesmen and engineers have from the earliest days of railway construction had the longitudinal project in their minds. The first section of the present "Red Central" was laid in the valley immediately after the inauguration of the Valparaiso–Santiago Railway, which was of course a primary necessity. Even when Chile's first concession, that of the Coquimbo–Ovalle Railway, was granted in 1855, it was stipulated that its line should be of the same broad gauge (*i.e.* 5 feet 6 inches) as that of the Santiago Railway, with which it would be ultimately joined. The Government of that date, however, did not fully realize the difficult nature of the country separating the two lines, which has resulted in the longitudinal railways in the north being later constructed to the narrower gauge of 1 metre instead of 5 feet 6 inches.

A preliminary survey of the Republic such as we have outlined, had it then existed, would have shown that, contrary to popular belief, a longitudinal railway through Chile must certainly overcome greater difficulties than the earlier transverse railways built from the coast towards the Andes. Many of the peninsulas, now appearing as abrupt hill-spurs, cross the Central Valley at right angles. Even in its wider portions the main valley is cleft by river-beds, whose east-and-west gradients are of great assistance to the cross-country lines, but a proportionately serious obstacle to the longitudinal system. In the section of the Longitudinal Railway between Cabildo and San Marco, some 60 km. of rack railway with gradients as high as 6 per cent. were found necessary. Elsewhere a 3 per cent. gradient is common, and numerous tunnels varying from 300 to 1500 metres in length are employed.

As these difficulties became better known, the completion of the central longitudinal line was constantly postponed, and an alternative scheme

along the coast was advocated. This project was actually entered upon, and a line built northwards from Rayado, intended to reach the port of Los Vilos, is a section of it; but the comparatively small value of a coast railway, either for strategic or commercial purposes, lead to a revival of the Central Valley scheme. In 1908, in the face of strong opposition, President Montt passed a law sanctioning the construction of such longitudinal lines as were necessary to finish the line to the Gulf of Chiloe in the south and, by providing links between the isolated northern systems, to establish a continuous railway between Santiago, the capital, and its northernmost terminal at Arica. Save for the final prolongation to Arica, this programme was completed in 1914, and rail communication from north to south now exists between the port of Pisagua (Dept. Tarapacá) and Puerto Montt, a distance roundly of 3000 km. of track. Three different gauges are employed on these through lines, viz. 1 metre 4 feet 8½ inches, and 5 feet 6 inches.

TABLE E.

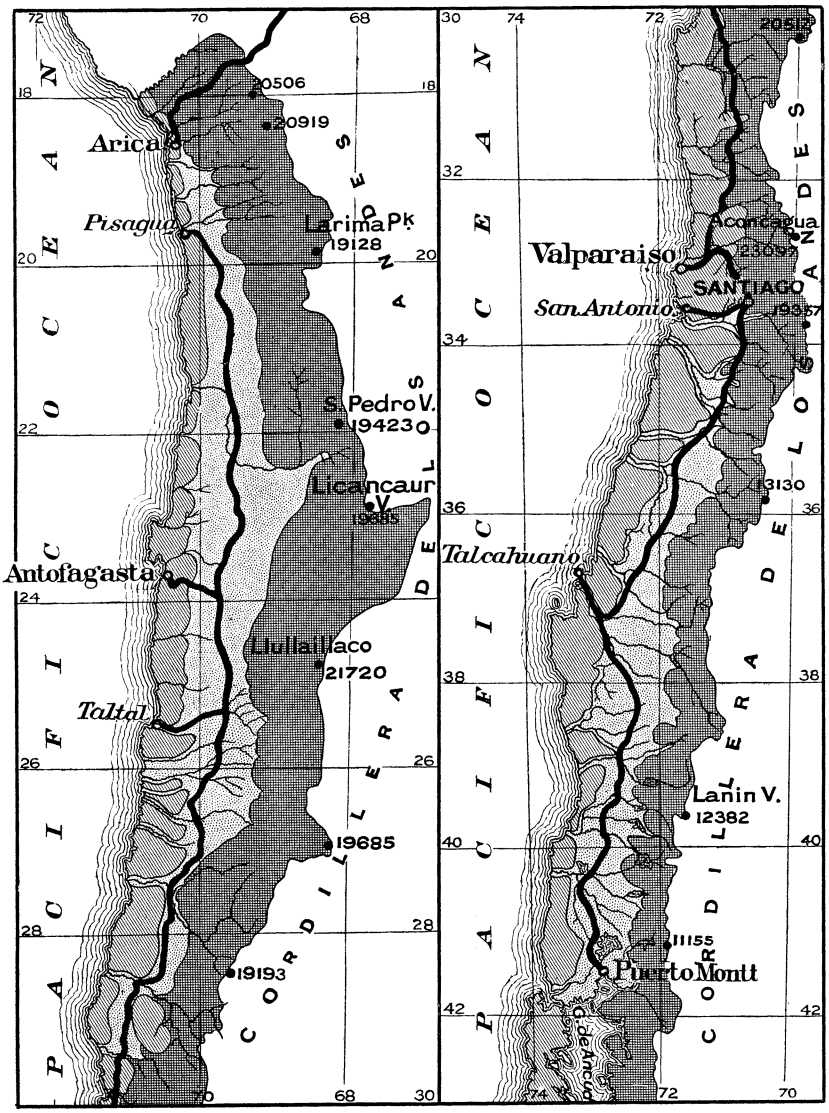
Proportion of Railways operated by State and by Private Companies in South America (1914–15).

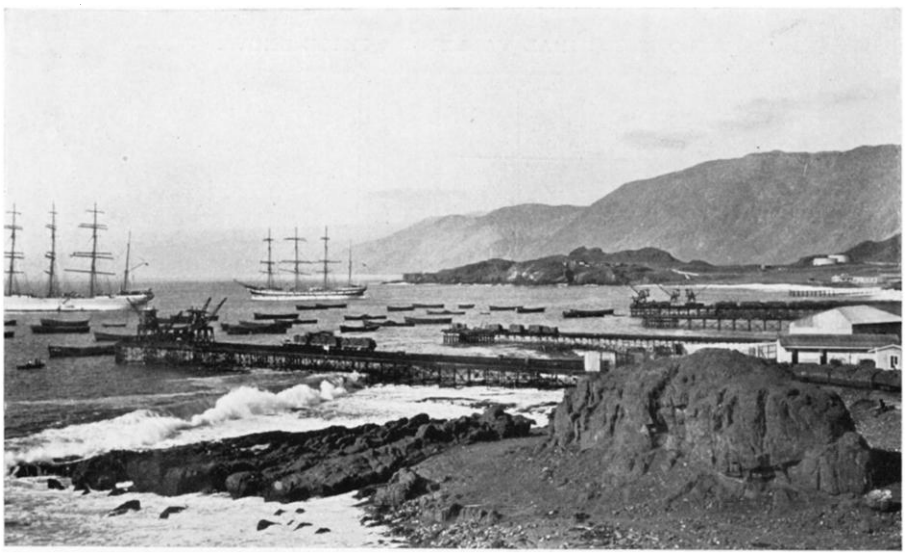
	Total of all Railways, 1914-15. Km.	*Railways operated by private companies. Km.*	*Railways operated by State. Km.*	*Proportion to total. Operated by private companies. Per cent.*	*Operated by State. Per cent.*
Brazil	25,506	21,587	3,919	84·6	15·4
Uruguay	2,585	2,562	23	99·1	0·9
Paraguay	587	587	—	100·0	—
Argentina	36,531	30,026	6,505	82·2	17·8
Chile	8,379	4,805	3,574	57·4	42·6
Bolivia	1,333	1,092	241	82·0	18·0
Peru	2,828	2,828	—	100·0	—
Ecuador	644	644	—	100·0	—
Colombia	1,108	878	230	79·3	20·7
Venezuela	936	936	—	100·0	—
British Guiana ...	152	152	—	100·0	—
Dutch Guiana ...	140	140	—	100·0	—
Totals for all South America	80,729	66,237	14,492	82·05	17·95

NOTE.—It should be noted that while operation of a railway in South America by the State always implies State ownership, the same rule does not hold good with regard to railways operated by private companies. The present State policy throughout the Continent is for Governments only to grant concessions which embody eventual purchase by or reversion to the State. The proportion of Government-leased or owned lines in all Republics is much larger than would appear by the above table, many such being operated, under different charters and state guarantees, by private companies.

Chilean State Railways.—The energy with which Chile has attacked her transport problems appears in Table E, which shows that her kilometrage of State-owned *and operated* railways is higher in proportion to the total than in any other Republic. Sixty-one per cent. of the 8379 km. of railways in Chile are actually owned by the Government, and of these 3574 km., or 42 per cent., are operated under the State railway system.

THE GREAT LONGITUDINAL VALLEY OF CHILE SHOWING RAILWAY





TALTAL PORT AND RAILWAY, CHILE

ARICA-LA PAZ RAILWAY WORKS AT ENTRANCE TO QUEBRADA PUJIOS

A study of Table B (see the March number of the *Geographical Journal*, page 165) will show, however, that although her statesmen early appreciated the advantages of a uniform gauge within the Republic, there is no country in South America which has departed further from its first ideals in this respect. Although the majority of the "freak" lines are short, nothing can gloss the fact that there are twelve different gauges under operation in Chile to-day.

The President's message of July 1913 stated that at that date 2575 km. were in construction, while surveys for an additional 5103 km. were in progress, including the last prolongation of 210 km. on the longitudinal from Zapiga station (opposite Pisagua port) to Arica, the starting-point of the Arica–La Paz (Bolivia) Railway. The war has temporarily stopped construction, but if this final section is carried through Chile will have a complete rail system from the Peruvian frontier south to Puerto Montt, and the only section of this long line not in the hands of the State will be a portion of the Nitrate Railway Company's lines between Zapiga and Pintados.

Transandine Railways and Projects.—Possibly owing to the restless character already noted in the Chilean nation, their railways include a surprising number of lines which profess as a final objective the crossing of the Andes. In addition to the three existing international lines leading out of Chile (the *Arica–La Paz*, the *Antofagasta and Bolivia*, and the *Chilean Transandine*), the following are a few of the so-called Transandine railways surveyed or constructed, which figure largely in official and other printed matter :—

List of Chilean Transandine Projects.

(*Figures of kilometrage given in brackets indicate the distance from Santiago to the various terminal points along the Central main line at which the branch railway starts. It will be noted that these projects are more numerous south of the Valparaiso–Buenos Aires route, where the passes of the Andes quickly lower their elevation.*)

1. From Mejillones to Salta (see also "The First Transandine Railway," *Geographical Journal*, November 1910).
2. „ Copiapó to Tinogasta : "Copiapó Railway."
3. „ San Bernardo (km. 16) *viâ* San José and Volcan : "Transandino por Maipó."
4. „ Tinguiririca (km. 139) *viâ* Las Damas.
5. „ Curicó (km. 185) *viâ* Los Quenes and Planchon.
6. „ Talca (km. 250) *viâ* Risco Bayo : "Transandino por Maule."
7. „ San Carlos (km. 374) *viâ* Naheuve River : "Transandino por Nuble."
8. „ Chillán (km. 398) *viâ* Recinto.
9. „ General Cruz (km. 446) *viâ* Polcura.

10. From Monte Aguila (km. 465) *viâ* Trupán and Antuco: "Transandino por Antuco."
11. „ Caucatin Puá (km. 637) *viâ* Lonquimay and Pino Rachado: "Transandino por Neuquen."
12. „ Cajon (km. 680) *viâ* Llaima.
13. „ Loncoche (km. 770) *viâ* Villarrica.
14. „ Collilelfú (km. 851) to San Martin de Los Andes *viâ* Lake Rinihue: "Transandino San Martin."
15. „ Valdivia to San Antonio (*viâ* Lake Nahuel Huapi).

Even should the above fifteen courageous lines scale their mountain barriers, only the Caucatin–Pua and the Collilelfú constructions have any present prospect of finding a counterpart on the Argentine side of the frontier.

The Collilelfú to Pirehueico, or "Transandino San Martin," to give this enterprise its more popular name, aims at linking up a series of three long narrow lakes, lying within the Andean valleys of Patagonia, where their general course is east to west. Of these lakes Rinihue and Pirehueico are on the Chilean side, and Lake Lacar on the Argentine. The San Martin Company has connected these lakes with the "Red Central" State system of Chile by a series of short, linked lines. So far the scheme is rational; but beyond the frontier the only possible connection would be by a prolongation of the Argentine (Patagonia) State Railway building inland from Port San Antonio. This line has already traversed the Patagonian tablelands; but between its present railhead and Lake Lacar lie tangled masses of mountains, which could only be crossed at heavy expense for the sake of a scant cattle traffic. Moreover, it duplicates the Buenos Aires and Great Southern line through Neuquen, only 150 km. further north. The project is so unattractive as to hardly merit discussion, were it not that this Argentine section is frequently referred to officially as the "Trans-continental de San Antonio a Valdivia."

The Caucatin construction, on the contrary, which starts from Pua station on the "Red Central" (642 km. south of Santiago) and runs its broad-gauge track towards the Andes, is definitely destined to be the Chilean section of the second Transandine and Trans-continental route, connected by the lines of the Buenos Aires Great Southern Railway to an Atlantic terminal at Bahia Blanca (see also reference under "Argentina" earlier in this paper). The pre-war date for completion of the Argentine section was fixed at 1919.

The remaining thirteen projects above tabulated are frequently referred to in Chilean publications as if they were already part of some complete Trans-continental system, in spite of the fact that the much more lengthy sections on the Argentine side are, and seem likely to remain, entirely absent. The advocates of these costly constructions cannot even claim, as is the case with parallel projects in Peru, that they link a Chilean

hinterland lying east of the Andes to the Chilean seaboard. Such projects therefore must be attributed to the impatience felt by a virile and ambitious people, living in provinces hemmed straitly between the mountains and the sea, rather than to any serious study of the requirements of the Republic as a whole.

Chilean International Railways.—The "Transandino por Juncal," *i.e.* the Valparaiso–Buenos Aires line, is not only the single railway running between Chile and Argentina, but the only Transcontinental line so far completed in South America. The details of this line have been often given; the impression however that the railway is a single working unit will bear correction. In reality the line connecting the Chilean and Argentine capitals is a chain composed of six links, each the property of a separate company, viz. Valparaiso to Las Vegas (91 km.); Las Vegas to Los Andes (45 km.); Chilean Transandine (70 km.); Argentine Transandine (178 km.); Mendoza to La Paz (140 km.); and La Paz to Buenos Aires (923 km.). The total distance from Valparaiso to Buenos Aires is thus 1445 kms., of which the entire Argentine portion is practically controlled by the Buenos Aires and Pacific Railway. There is a change on either side of the Andes from broad to metre gauge, the rack system being freely used on the latter (Transandine) sections. Partly owing to this fact, during the winter months, that is to say, from June to October, serious breakdowns and delays have been the rule rather than the exception on the Transandine lines, especially on the Chilean side. This is due not only to heavy snowfalls among the mountains, but also to the more serious defect that open portions of the line at its highest point, *i.e.* below the summit tunnel, and well within the snow-line, are laid on a hillside whose surface is subject to mud-slides and boulder-falls at each melting of the winter snows. The cost of a new tunnel at lower levels would be at present prohibitive, probably involving the use of electric motive power. The only alternative to the constantly recurrent blocking and pinching out of this part of the line is to convert the dangerous portions into an integral part of the mountain-side by extensive retaining walls and concrete snowsheds, thus adding heavily to an already excessive expenditure. It will be instructive here to compare the construction cost to date and the cost of the three most spectacular undertakings in South America. The Argentine and Chilean Transandine Railways, totalling 248 km., have cost £4,462,000. The Madeira–Mamoré Railway of 364 km. cost £4,700,000. The 247 km. of the São Paulo Railway have accounted for £6,600,000. Heavy fresh expenditure is foreshadowed on all three lines.

The Arica–La Paz (International) Railway, which starts from the port of Arica (formerly Peruvian territory) and ascends the Andes to La Paz, has supplied Bolivia with its latest and shortest Pacific coast outlet, effecting a saving in distance of 500 km. as compared with the alternative Chile–Bolivia route from Antofagasta port. The up-journey on the Arica route

occupies about eighteen hours by passenger train, with some saving in time on the down journey. Thirty-six km. of rack rail with maximum 6 per cent. gradient are employed, many of the disadvantages of the rack system being minimized on this arid and waterless coast section. The Arica–La Paz railway is probably the only strategic line, in a strictly military sense, in South America, although it is not openly so declared. It safeguards to Chile the ownership of the nitrate provinces of Tacna and Arica, provisionally administered by Chile after her war with Peru. Their title to ownership has never been definitely agreed between the two Republics, the decision being nominally reserved for a plebiscite of the population affected, the date of which is constantly postponed. Furthermore, the coast strip comprised in these two provinces was always recognized as Bolivia's freehold on the Pacific Ocean. Under a treaty made in 1904 the Chilean Government undertook, in return for cancellation of all claims to a coast frontage by Bolivia, to construct and pay for the Arica–La Paz railway. A further Protocol, however, signed at Arica in May 1913, on the opening of the line, specified that until May 1928 both the Chilean and Bolivian sections are to be operated by the Chilean Government. When the fifteen years have expired the Bolivian section will be handed over to the Government of that country. The construction of the Arica–La Paz railway thus not only gives Chile further vested interests in provinces whose ownership is still disputed by Peru, but also confirms the short-sighted blockade which makes of Bolivia the only Republic in South America (save the entirely different case of Paraguay) lacking its birthright of an ocean frontage.

BOLIVIA

Like Paraguay, Bolivia is an inland Republic. Political necessity has time after time forced her to relinquish her claims, both historical and geographical, to outlying portions of her territory, so that to-day the country's formidable natural ramparts mark interior rather than exterior boundaries. Her lands are a hinterland to the maritime States, and much of her outlying territory is, save for the political tie, more closely connected with the progress of these adjacent Republics. In spite, or because of this fact, no fewer than three international lines already cross Bolivia's borders, and two more will shortly be finished. Those in operation are (1) *The Peruvian Southern Railway* from Mollendo to Lake Titicaca, which enters La Paz through its control of the Guaqui–La Paz Railway, the through service having been in operation about seven years; (2) *The Arica–La Paz* (State) line, which was formally opened in May 1913, the shortest route to the Pacific coast; and (3) *The Antofagasta and Bolivia Railway*, serving the Bolivian plateau, which completed its direct connection with La Paz in 1915. To these will shortly be added (4) a line linking *Uyuni* (*Antofagasta Railway*) to *La Quiaca* on the Argentine frontier, of which 201 km. are still under construction for

Government account; and (5) an *extension of* 120 *km.* of the Brazilian *Madeira–Mamoré Railway* bridging the latter stream and passing through Bolivian territory to Riberalta, above the Esperança Falls of the Lower Beni. This line has also been commenced, but construction is at present suspended. The possession of five international lines will constitute for Bolivia a South American record.

The Pacific Outlets.—We may first usefully review the three lines which connect La Paz with the Pacific coast. The *Antofagasta and Bolivia* line begins on a 2 feet 6 inch gauge, but changes to the Bolivian 1 metre gauge at the frontier. On its further northward route along the plateau the railway connects by branch lines with the chief Bolivian provincial capitals, viz. Tupiza, Potosi (whence an extension is planned to Sucre, the ancient capital), Oruro, a mining centre, and Cochabamba, the garden city of the eastern Andes. From Antofagasta port to La Paz the line is 1162 km. long, and the journey occupies forty-three hours.

The ascent by the *Peruvian Southern Railway* from Mollendo to Puno is made on the standard (4 feet 8½ inches) gauge, the distance being 524 km. Then comes a picturesque steamer trip of some 200 km. on Lake Titicaca (12,838 feet above sea-level) as far as the Bolivian port of Guaqui, in full view of the snow-clad inland Cordillera, rising to over 22,000 feet from the peaks of Sorata to the splendid saddle-crest of Illimani. The summer snow-line of the Andes in Bolivia and Peru occurs at about 16,000 feet. A further 98 km. of line leads from Guaqui port across the stony "Alto," winding up with a sensational 1400-feet descent on an 8 per cent. gradient by electric line into the deep valley of La Paz River, in which the Bolivian capital lies hidden. The total rail and lake journey from Mollendo is therefore about 822 km., and the down journey is covered in twenty-eight hours. A projected loop from Puno to Guaqui, round the western shore of the lake, would materially shorten the time though not the distance covered. The journey on the Peruvian southern branch from Puno, which crosses the transverse Vilcanota range (14,536 feet) to Cuzco (11,000 feet), the ancient capital of the Incas, should be made by all travellers wishing to catch a glimpse of old Peru. Should Cuzco ever be joined by rail to the Peruvian Central (Oroya) line, this branch will form part of the much-discussed railway along the Andean plateau, which would link Lima to La Paz, and so with Buenos Aires.

The third Pacific line, *Arica to La Paz* (already noticed under "Chile"), is only 439 km. in length, with a journey of eighteen hours. This route has the added advantage that Arica harbour offers a better anchorage for ocean vessels than either Mollendo or Antofagasta roadsteads.

All these three mountain lines scale the coast Andes at high altitudes. The summit pass on the Antofagasta Railway at Ascotan is nearly 13,000 feet, and thence north along the Bolivian plateau the railway runs at an almost uniform level of some 12,000 feet. A spur line to the Collahausi mines reaches 15,809 feet, and the Potosi branch crosses the inland Andes

at 15,814 feet. The Southern Railway crosses the Pacific water-parting at 14,666 feet near Crucero Alto (259 km. from Mollendo). Both the Antofagasta and the Peruvian Southern railways use ordinary adhesion in ascending to these great altitudes, the latter employing a maximum 4 per cent. gradient over considerable distances. The Arica–La Paz line, however, which ascends by the waterless Quiroz defile and crosses the coast range at 14,100 feet, uses 36 km. of rack section at different points. On all these Bolivian lines, as well as on the other Pacific coast mountain railways, the traveller must revise his ideas of what a locomotive may be legitimately asked to do. Overshadowed by the giant bulk of the Andes, or standing on the interminable stony plateaux of the Altaplanicie, he will regard the solitary rail-track, the standing evidence of incredible pioneer toil, with a personal affection that more complicated transport systems at home quite fail to arouse in his breast.

The major problem which from early days has confronted Bolivian statesmen, namely that of gaining an undisputed outlet for their country westward to the Pacific coast and eastward to the Amazon main river, has therefore now been solved, though only at heavy sacrifice of Bolivian soil, by Chile's undertaking of the Arica–La Paz line on the coast, and in the hinterland by the building of the Madeira–Mamoré Railway by Brazil. Bolivia was at the same time granted by Brazil the right of free navigation on the Acre, Madeira, Amazon, and Paraguay rivers. The further task of uniting Bolivia's remaining outlying provinces by rail with La Paz has yet to be faced. This eternal problem especially affects the department of Santa Cruz, in the south-east, adjoining the Paraguayan and Argentine Chacos. The Santa Cruz pampas offer the finest area of undeveloped cattle pastures in South America, outside of Argentina. They lie 500 to 1000 feet above sea-level, from the Pilcomayo River as far north as the low Chiquitus Sierras, near the source of the Paraguay. Failing early rail connection with La Paz, the development of this productive zone will probably devolve on Argentina. (See also section "Argentina" in March *Journal*, page 192.)

The Amazon Outlet.—The second outlying territory in urgent need of rail connection with the Bolivian plateau is that lying upon the eastern slopes of the Andes, comprising about one-half of the total area of the Republic. Its sole outside means of access is at present from the Amazon and the Atlantic coast by the Madeira–Mamoré Railway. In this condition it is likely to remain some considerable time, for the problem of constructing railways down the Eastern Andes is no light one. Neither Bolivia, Peru, Ecuador nor Colombia, all Republics with a vital interest in attaching their tropical Amazon hinterlands by rail to their capitals, have yet succeeded in the task. Throughout this whole region the passes of the inland or snow-clad Cordillera (which in Bolivia forms the main Andes) vary from 15,000 to 17,000 feet in height. A natural passage from the Altoplanicie to the Amazon basin is found in the gorge of the La

Paz River, whose headwaters have eaten back through the range round the base of Illimani. The La Paz valley route however presents equal difficulties in railway construction and is moreover much longer than the high direct route across the range, planned from La Paz to the fertile Yungas district. Even allowing for a long summit tunnel, a line built anywhere down the north-west Andes on the Amazon side must drop at least 12,000 feet before reaching any practicable river navigation. The mountain flanks are soaked with a heavy rainfall and smothered in jungle vegetation grown on rotting limestones and creeping shales. Similar railways actually in operation are the Girardot line, which ascends 8000 feet from the Magdalena River to the Bogotá plateau, and the Guayaquil–Quito Railway. Even these pioneer examples of mountain-railroad building in the north-west tropics of South America hardly forecast the difficulties which await the operation of the first railway from the Altoplanicie down into the Amazon basin. The Antofagasta Railway has, nevertheless, already made a long step in this direction by its branch across the inland Cordillera, from Oruro (12,121 feet), to the railhead now nearing Cochabamba (8367 feet). From Cochabamba a light electric railway carries the metre-gauge 20 km. further, and routes have been surveyed for another 200 km. to the navigable waters of the Chimoré, Securé, and Chapuré rivers, which eventually flow to the Madeira. Should any extension downhill from Cochabamba be ultimately built, it would thus prolong the difficult mountain section already overcome by the Antofagasta and Bolivia Railway constructions.

Apart from political motives, the primary object of prolonging Bolivia's transandine railways down to the Amazon basin is not to establish an outlet for her upland exports, *viâ* the Atlantic, a route which obviously could not compete with the shorter route to the Pacific ocean and thence to European and North American markets, especially since the opening of the Panama Canal. These Amazon projects are planned to supply the bulk of the nation, who live on the barren Altaplanicie, with tropical foodstuffs such as maize, mandioca, fruits, with the indispensable coca-leaf, and above all, with fuel which is completely lacking in Upper Bolivia. The utmost industry of the Indian on the "Alto" only achieves a little barley and patches of frost-bitten potatoes, although sheep and llamas on the hillsides and a few hardy cattle in the valleys find sufficient pasturage. The Altaplanicie, however albeit barren and cold, is extremely healthy. Despite its greater fertility, the Bolivian Indian dreads life in the low-lying hinterland, with its rubber plantations, its fevers, and its insect pests. Following the Inca traditions, centres of Bolivian population cluster round the snow-capped Andes and their high-perched lakes. As railway constructions stand at present, the first tropical and forest produce to reach the Altoplanicie cities direct by rail, instead of on muleback, will probably come from Jujuy and the Argentine Chaco, as soon as Bolivia completes the Uyuni–La Quiaca gap in her international line southward.

These Altaplanicie, or main valley floors of the high Andes, which extend for 2000 miles from northern Ecuador to Argentina, are composed chiefly of clay and boulder conglomerate, filled to its present uniform level by inland drainage and violent flood action, which diminished with the gradual desiccation attending successive uplifts of the Andes. Excellent cross-sections of this floor are shown for 1000 feet below the general surface level in the La Paz Valley, and I observed a similar section near the Quinza Cruz Sierra, about 100 miles further south. The summits of half-covered hills rise along these central plateaux like islands out of a stony sea. The Altaplanicie of Bolivia, to counteract its barrenness, is one of the most highly mineralized regions in the world. Transport troubles are minimized by the fact that many of its mines yield precious or semi-precious metals. Of these latter, copper, tin, antimony, wolfram and bismuth are the principal, but silver-mines at Potosi and elsewhere maintain their old Spanish reputation, while all the inland Andes, especially in their lower slopes and Amazon river-beds, yield gold. La Paz itself is founded on an old placer-gold deposit. It is for the development of Bolivia's mineral resources that the completion of the through railway from La Paz to Buenos Aires is chiefly desired. The citizen of Argentina who travels north from the pampas to this high country will see from his Pullman car a new land with strangely new horizons. To Bolivia there appears to be a natural complement between the limitless yield of the pastures and corn-fields of Argentina and the no less real but unexploited mineral treasures of her own mountain ranges.

It is perhaps due to the certainty that such reserves of treasure really exist that the traveller in Bolivia notes there a general optimism. After a long period of virtual isolation from their neighbours, the results of the strenuous Bolivian railroad programme of the last ten years are now showing. Bolivia has definitely resigned her ocean frontage and accepted her position on the high Andean hinterland, but she still holds an important central position with well-established roads guaranteed to either ocean. The mere area of the cloud-capped Republic—it ranks fourth in South America—entitles Bolivia to the respect of her neighbours. If the gaps between the Bolivian, Peruvian, and Argentine railroad systems along the high Andes are ever completed, we may see a readjustment in the relative values of the Pacific coast lines. In the long run the "Inca Highway," the old Altaplanicie route from north to south, will reassert its influence and La Paz will then lie, as the Spanish viceroys planned it, on a trunk road connecting Buenos Aires with Lima. Such Transandine lines as ascend from the Pacific shore, and even cross the Andes into the Amazon hinterland, will in that case become the feeders or the coast outlets of an international railroad system on the high plateaux in which Bolivia will form the central and most important section.

Reference :

1. Nictheroy–Parahyba Valley (Leopoldina R., Fribourg section).
2. Rio–Parahyba Valley (Leopoldina R., Theresopolis section).
3. Rio–Parahyba Valley (Central of Brazil R., North branch).
4. Rio–Parahyba Valley (Central of Brazil R., São Paulo branch).
5. Santos–São Paulo (São Paulo R.).
6. Paranagua–Curityba (São Paulo–Rio Grande R., Parana section).
7. São Francisco–Iguazu Valley (São Paulo–Rio Grande R., Sta. Catharina section).
8. Valparaiso–Mendoza (Argentine and Chilean Transandine Rys.).
9. Antofagasta–La Paz (Antofagasta and Bolivia R.).
10. Arica–La Paz (Arica–La Paz R.).
11. Mollendo–Lake Titicaca (Southern of Peru R.).
12. Lima–Oroya (Central of Peru R.).
13. Guayaquil–Quito (Guayaquil–Quito R.).
14. Bonaventura–Cali (Pacific (Colombia) R.).
15. Magdalena R.–Bogota (Girardot (National) R.).
16. Puerto Cabello–Valencia (Puerto Cabello–Valencia R.).
17. La Guaira–Caracas (La Guaira–Caracas R.).

GUAQUI PORT, LAKE TITICACA, BOLIVIA, AT SUNSET

SNOW-PACK AT 18,500 FEET, KINZA CRUZ, BOLIVIAN ANDES

PERU

Railroad expansion in Peru can normally proceed only in three directions. The first is along the desert coast from port to port, crossing numerous dry gulleys and a few irrigated valleys. The second location (roughly parallel to the coast) lies among the valleys and peaks of the high Andes which run from Lake Titicaca to Ecuador. The third, embracing the majority of Peruvian lines, comprises the various routes heading from the Pacific up the flanks of the coast Andes and also those which boldly attempt the crests of the high Cordillera. There are in addition many Transandine projects into the Amazon Valley, but for the present they remain mere projects.

The Pacific Coast Lines.—Peru's Pacific shore-line is 1400 miles long (about the distance from Buenos Aires to Magellan Straits), but its only real port—with the possible exception of Chimbote—is Callao, whose sheltered anchorage, just south of the fertile Rimac Valley, determined the location (some 12 miles inland) of Lima, the capital. This dual function of capital and port places Lima on the same footing as Buenos Aires and Rio, a noteworthy fact since the neighbouring capitals of La Paz, Quito, Bogotá, and Caracas are all set upon high plateaux overlooking the sea approach. Lima's unexpectedly cool climate is partly responsible for this choice, and partly the irrigation value of the lands tributary to the Rimac stream, which yields much of the food and other amenities necessary for the existence of the Peruvian capital. The chief centres of population in Peru do not lie behind the coast Cordillera, as in Bolivia, but mostly front upon the Pacific. The possession in this coast region of valuable guano and more recently discovered oil deposits, both important factors in the country's revenues, further promotes the seaboard population.

The Andes of Peru form an even more formidable barrier to the country's development than is the case in Bolivia. Moreover, the problem of surmounting the barrier is one that concerns Peru alone; no neighbouring state has any direct interest in assisting her. As in Bolivia, the fertile, *i.e.* the tropical, portion of the country faces the Amazon basin. Between this hinterland and the capital lying upon the barren Pacific coast lies a tangled mountain mass, through which there is no easy gateway. The only break in the coast Andes of Peru is at the Paita Pass (which will be later referred to) where the levels drop to 6500 feet, but elsewhere the Pacific coast passes vary between 14,000 and 15,000 feet. The inland or eastern Cordillera, on the contrary, is deeply eaten into by a network of waterways uniting in the rivers Ucayali, the Huallaga, and the Marañon itself, for northern Peru embraces the true headwaters of the Amazon, and 95 per cent. of the country's total drainage falls into its basin.

Although the line between Lima and Callao was the first to be completed on the Pacific coast (see Table F), Lima is to-day more out of touch with its provinces than any other South American capital, excepting possibly

Bogotá, in Colombia. There is of late, however, a tendency on the part of the isolated northern railways of Peru, built originally as transverse lines, to extend along the coast to Lima. The Lima–Huacho Railway (214 km.) is a concrete example of this coast-wise trend, while a line from Lima south to Pisco (246 km.), though not yet built, was actually surveyed as far back as 1864. Such coastal links will probably continue from time to time until they merge into a connected system joining Lima to all the more important northern and southern Peruvian ports, on somewhat the same plan as the Longitudinal Railway of Chile.

Everywhere along this seemingly desert coast the soil is intensely fertile under irrigation. Sugar-cane is cut throughout the year, while Peruvian coast cotton is considered equal to the best Egyptian. The heat radiating up from the desert strip appears to keep all clouds from crossing the Cordillera; occasionally, however, a cloud-burst comes over to the coast, and its erosive effect on the loose, porous soil is almost incredible. Although the interval between such phenomena averages five years, it fully explains the deep erosion to which the flanks of the hills facing the sea have been subjected, and which forms a further obstacle to the lines seeking to scale their flanks.

The Transverse Lines.—All the thirty railways officially recognized as separate companies in Peru originated on the coast, to carry produce from some irrigable valley to the nearest port. At distances from 20 to 100 km. inland, according to the bends of the coast and the sweep of the Cordillera, such lines begin to ascend the hill-slopes or river valleys, and the majority stop thereon, at heights varying from 2000 to 4000 feet. But like Napoleon's soldiers, each of whom carried a possible marshal's baton in his knapsack, every Peruvian railway, before it loses sight of the Pacific, is in the eyes of its promoters a potential Transandine, if not a Transcontinental system. The more ambitious lines, politically supported or tempted by mining prospects, thus obtain concessions granting them the barren privilege of attempting the appalling slopes ahead.

When we remember the enormous cost and the engineering difficulties overcome by the seven lines which at this date have alone succeeded in scaling the coast Andes, in the 4000 miles lying between Puerto Montt in Southern Chile and Panama, it is not surprising that in Peru only two transverse lines, the *Central* and the *Southern*, should have realized this ambition. Construction on the Central Railway commenced in 1870, but not until 1893 was it completed to Oroya, a distributing centre on the plateau, about 30 km. beyond the coast summit. The line was a prolongation of the original Callao-Lima Railway, a rash acceptance of the tempting invitation to ascend the valley of the Rimac River, which makes a straightforward plunge here from the snows of the Andes to the Pacific shore. The construction of the Central line includes sixty-five tunnels and sixty-seven viaducts. Though both daring and picturesque it presents serious drawbacks in operation, and a much better, even if less picturesque and

longer, line could have been found by surveying the Andean approaches and passes a little further north. Like the majority of Peruvian roads, the Central is built to the standard (4 feet 8½ inches) gauge, a fact in itself sufficient to disprove the South American fallacy that only "narrow-gauge" lines are adaptable to mountain grades. Passenger trains ascend in eight hours the 150 km. from Lima (500 feet above sea-level) to the summit tunnel at 15,665 feet. The Rimac Valley narrows so steeply between its confining head-walls as to preclude any development even by using the uniform 4 per cent. gradient, and in such emergency the railway side-steps up the hillside in a series of "V" switchbacks. Before entering the summit tunnel a short branch line departs overhead among the glaciers to an altitude of 15,865 feet, serving the copper-mining camp of Morococha. Thus the Peruvian Central Railway can claim the somewhat barren honour of operating the highest railway in the world, though the Antofagasta and Bolivia Railway operates two branches, *i.e.* to Collahuasi and Potosi, whose tracks come to within a few feet only of this great altitude.

The Southern Railway of Peru, which starts from Mollendo port—or rather breakwater, for Mollendo lies in an open roadstead—has already been noticed (*vide* Bolivia) as one of the three coast railways leading to La Paz. Transandine lines, both in Peru and Bolivia, in addition to fuel difficulties on the high plateau, have to face an excess of outward over inward freights, sometimes as high as six to one. That is to say, for every six full train-loads despatched to the coast five empty trains must be hauled up the hill. This disadvantage is chiefly owing to the low standard of living of the Indians who form the bulk of the population. But it is much easier to criticize from a distance the operating results of these adventurous lines, than to recognize at its proper value their stimulating effect on the countries set astride the great Andes of the north-west Pacific shore. Especially valuable are the opportunities they grant to such travellers as desire to visit within a reasonable time-limit one of the most historic, picturesque, and interesting regions of the two Americas. When the present war is ended and the Panama Canal in full working order, this section of the southern continent will attract, thanks to their pioneer work, a far wider and more intelligent interest than it has heretofore enjoyed, not only from foreigners but also from the citizens of other South American Republics.

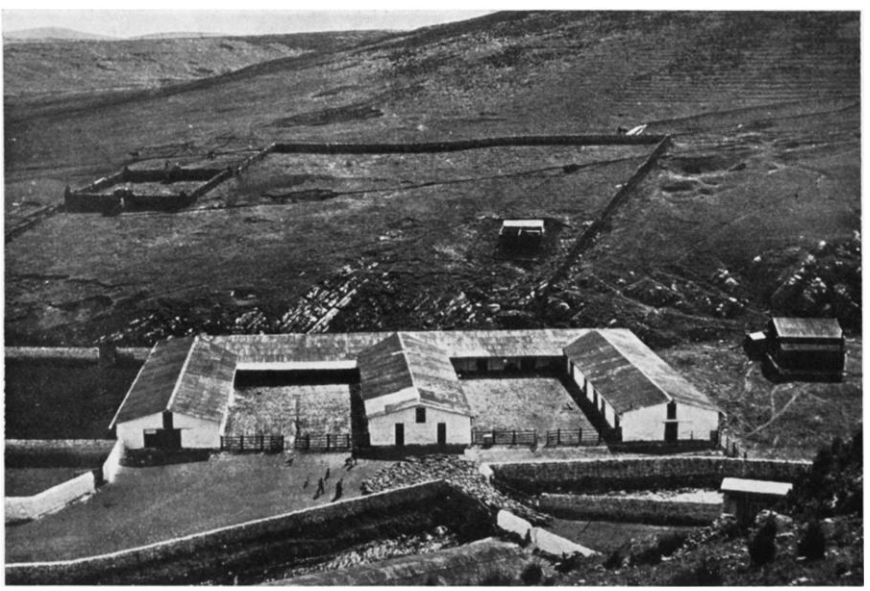
Peru has many interesting Transandine projects, notably the line over the Paita Pass in the north, where the Andes drop to 6500 feet. The lowness of the gap at this point is counterbalanced, however, by the fact that in order to reach Amazon navigation from the coast two inland ranges of almost equal height must be crossed, making the total of mountain construction equal to that at any other point. Another project is the prolongation of the Chimbote line up the fertile valley of the Rio Santa, which cuts the coast range. Even if the railway negotiated the coast gorge it would be confronted by the inland Andes before reaching the Marañon

river. This, the true headwaters of the Amazon, runs north and parallel to the coast for 300 miles before it breaks through the final defile, or "Pongo," of Manseriche, and so unites with the main Amazon stream. The construction of these and similar Transandine projects in Peru will necessarily depend on the results shown by the railways already partially traversing the Cordilleras. Existing lines which have already scaled the coast range of the Andes will certainly be in a position to attempt the yet more difficult Amazon slopes, long before those constructions still halting near the Pacific coast, whose advance, however desirable, it is beyond the present power of the Government to assist.

Altaplanicie Lines.—There are only two short extensions of railway on the Peruvian tablelands, both worked by the Peruvian Corporation as a part of its Transandine lines. The first is the branch of the Southern of Peru Railway (already noticed), running from Juliaca junction to Cuzco. This line crosses at La Raya Pass (14,536 feet) the Sierra of Vilcanota, which forms the northern dam of Lake Titicaca and the Bolivian lacustrine basins to the south. Further north, along the Altaplanicie, the Central Railway, reaching Oroya by the Rimac Valley, branches **T**-shape among the Andean plateaux. One arm comes 120 km. south to Huancayo, and is under construction a further 180 km. due south to Ayacucho. From Ayacucho a prolongation to Cuzco would involve, according to preliminary surveys, another 500 km., though it appears improbable that any railway should wish to negotiate the wild and desolate gorges of the Apurimac river, lying directly between these two points. In highly mineralized countries like Peru or Bolivia, however, there is always the possibility of some mining railway contradicting conclusions based only on the topographical surveys of any given region. Mining railways cannot have their routes foretold or classified, since their construction depends on calculations as to the life and possible value of a mine, set against the cost of transport. Thus when a mining railway coincides with any other railway programme, it is usually more from chance than of set purpose. An example is the second or northward arm of the Central Railway from Oroya to the Cerro de Pasco copper-mines (110 km.). After traversing the Juan Pampa, a plain of historic interest where Simon Bolivar, the founder of Peruvian and Bolivian Independence, defeated the Spaniards on 6 August 1824, this branch ends at the large Cerro de Pasco works and smelters, under American management, whose output is an important traffic item on the Central Railway. The mine-owners, having thus succeeded in bringing the Central Railway up to their property, now project a further extension on their own account down the eastern slopes of the Cordillera to a navigable point on the Ucayali river, whence shallow-draught steamers can proceed down the Amazon. This extension, as at present planned, would descend abruptly by a narrow-gauge line from Cerro de Pasco for 90 km. on 5 per cent. gradients, through the valleys of the Tinga and Huallaga, till it reached the Ucayali

CENTRAL OF PERU RAILWAY, "V" SWITCHBACKS IN RIMAC VALLEY

CENTRAL OF PERU RAILWAY, AYACUCHO VALLEY, 10,500 FEET



MESSRS. DUNCAN, FOX & CO.'S SHEEP RANCH IN THE PERUVIAN ANDES

river. After much activity in early surveys and concessions, the project now seems to be in abeyance.

Another example of mining activity aiding transport on the Peruvian plateau is the highway (not a railway), 200 km. long, built by the Inca Mining Company from Tirapata station on the Cuzco branch, down to the Inambaru gold district on the Upper Madre de Dios river, opening up a rich but frightfully broken country. Again, the discovery of large copper deposits at Ferrobamba, near the headwaters of the Apurimac, lately led to surveys for a railway following the plateau contours for 240 km. to a junction with the Southern line. An alternative survey was also made for a line direct to the coast, which could of course only be built at the sacrifice of the plateau line referred to. Both these projects have for the time being also fallen into abeyance. Thus while mining will probably form the principal basis for new railway constructions on the Peruvian highlands, no forecast can be made as to their location. The future Andean railways of Peru may lie to-day in the womb of any of her big hills.

Apart from the more spectacular mining industry, it is well to note that the plateau and the limestone flanks of the high inland Andes of Peru are already grazed by thousands of llamas, as well as by scattered flocks of native sheep, for which the short turf that grows from 11,000 feet up to the snow-line is admirably adapted. An interesting and successful experiment has been carried out by Messrs. Duncan Fox, who ten years ago imported 6000 well-bred sheep from the Straits of Magellan to form the nucleus of an Andean sheep-breeding industry on modern lines. The flocks have now increased to over 40,000 under the care of Scotch shepherds brought from the Orkneys, the whole undertaking reflecting great credit on Anglo-South American pastoral enterprise. We have the analogy of Patagonia to prove that wherever the guanaco runs—to which the llama and vicuna are first cousins—it is a sign of good "sheep country," and the logical inference is that 2000 miles of the Andean Cordillera in Ecuador, Peru, and Bolivia offer for sheep-breeding a region greater in area even if somewhat inferior in grazing quality to that of all Patagonia—a very interesting reflection. The comparative mobility of flocks on the high Andes will not directly call for railways, as does the mining industry, but any improvement in their quality will at once be reflected in the status of the landed proprietor as well as by a higher standard of living for the native Indian peasant-cultivator, on whom eventually progress in Peru mainly depends.

Peruvian Waterways.—In any discussion of Peruvian routes, we must not forget that most of its eastern hinterland is readily accessible through the tributaries and headwaters of the Amazon, once the river gorges of the "Montaña" country are passed. Twenty great streams within Eastern Peru have been surveyed to give over 7000 miles of navigation. Peru's chief Amazon port, Iquitos, 2000 miles up-river from Para, is visited by

ocean vessels of six thousand tons, and Amazon navigation extends from the Atlantic to a point only 300 miles in direct distance from the Peruvian coast. That is to say, seven-eighths of the distance lying between the Atlantic coast and the Pacific port of Callao can be traversed by river. Yet immovably blocking the access from Lima to these inland regions and the tempting Atlantic waterways rises the rocky mass of the Andes, and foreigners can at least sympathize with the feelings of helpless impatience, not unmixed with native pride, with which Peruvians contemplate that enormous barrier. Since March 1910 mails have been sent from Iquitos to Lima by a combined service of shallow-draught steamers up to the limit of Amazon navigation, whence connection is made by mule-train and carriers over the inland Cordillera to Oroya, and so down to the Pacific coast by the Central Railway. The service from Iquitos to Lima is scheduled at thirty-three days, but may be delayed by weather conditions up to fifty days, illustrating well the difficult nature of the country to be traversed.

The set-back given to Peru by her disastrous war with Chile arrested for an indefinite period any really constructive State Railway policy. Still, sooner or later (but more probably late than soon), the gap now separating the Central Railway from the Southern Peruvian Transandine systems will be closed, either upon the plateau or along the coast. At such time Lima, even if still separated from her provinces within the inaccessible Amazon basin, will then gain a fresh impetus, as the Pacific coast terminus of an international service passing through La Paz down to Buenos Aires.

TABLE F.

First Railway Constructions in South America.

	From	*To*	*Distance in km.*	*Gauge.*	*Construction Begun.*	*Finished.*	*Remarks.*
Peru ...	Callao	Lima	14	4 ft. 8½ ins.	June 1850	April 1851	Engine ran on 5 km. June 1850.
Chile ...	Caldera	Copiapo	81	4 ft. 8½ ins.	March 1850	Dec. 1851	Section Caldera–Algarrobo finished Sept. 1851.
Brazil ...	Rio Bay, Maña	Raiz de Serra	16·2	1·67 m.	April 1853	Dec. 1856	(F.C. de Maña) 14·5 km. finished April 1845 to Frajoso.
Argentine	Buenos Aires	Merlo (approx.)	23	5 ft. 6 ins.	Feb. 1855	Aug. 1857	In 1860 there were 39 km. of line on a single railway. Capital, $741,000 gold.
British Guiana	Georgetown	Plaisance	8·04	4 ft. 8½ ins.	1847	1848	Construction recommenced 1851.

Before leaving Peru we may settle a small but interesting historical detail. Both Chile and Peru claim the distinction of having built "el primer ferrocarril Sud-Americano," and the subject is often debated in the railway press of these and other countries [see preamble to 'Argentine Boletín de Obras Públicas.' Sección Técnica. Nov. 1911]. The confusion appears to lie in whether the definition of a "railway" depends—(1) on the completion of the original project, or (2) on the opening of any section of the same; and in this case (3) whether the line in British Guiana counts as "South American," since it so obviously anticipated both claimants! Table F will show the facts regarding actual construction. Dates of their concessions, etc., which in most cases were granted several years earlier, are ignored.

ECUADOR

Of the 644 km. of Ecuador's entire railway system in 1914,* 464 km. are accounted for by the Guayaquil-Quito line running between the port and the capital. Ecuador, like Paraguay, has practically only one railway.

Although the Republic is thus backward in railway mileage, its position and its topography furnish an excellent excuse. The parallel Cordilleras of the Andes contract within Ecuador to virtually a single range, or at best a twin range, enclosing the narrow valley in which stands Quito and every other important city outside Guayaquil. North of the Quito plain the range again contracts into the Knot or "Nudo" of Pasto, before it opens out into the three Cordilleras which traverse Colombia. The Ecuadorean Andes form a narrow, broken and lofty mass, which is highly volcanic, including many well-known active cones, such as Chimborazo and Cotopaxi. The flanks overlooking the Amazon Valley are excessively steep, and practically preclude any economical railway construction on this side, now or in the future. From the high plateau not even a mule track descends the Eastern Andes of Eucador, and it is with extreme difficulty that an active man on foot, assisted by Indian guides, can make the descent from Quito to the River Napo, the nearest Amazon tributary. Connection with the Amazon basin, however, is of less importance to Quito than to Lima or La Paz. Ecuador, with north-west Colombia, possesses the only portion of the Pacific coast of South America whose conditions parallel the tropical shores of Brazil. The Humboldt current strikes the Pacific coast at Tambez, just south of the Gulf of Guayaquil, where its moisture-bearing influence is seen in the abrupt change from the arid Peruvian shore-line to dense massed vegetation. The heavy rainfall which prevails from Guayaquil to Panama, has broken the coast range here into a succession of rugged and jungle-covered hills, easily accessible through numerous ports, into which fall short torrential rivers.

* "Reviewing the railway situation, 53½ km. of line have been completed during 1915–16, and 116 km. surveyed, while plans relating to a further 702 km. are under consideration by the Department of Public Works" (Message of the President at opening of Congress, from the 'Registro Oficial (Quito),' 11 August 1916).

The most important of these, the Guayas river, debouches into the Gulf of Guayaquil. Though its estuary is somewhat impeded by sandbanks, this river harbour affords good and sheltered anchorage, and through it passes 90 per cent. of the country's imports and 80 per cent. of its exports.

Guayaquil had as bad a reputation for yellow fever as formerly had Santos, Rio Janeiro, La Guaira, Panama, and Havana. The Panama Canal Commission, recognizing the serious nature of this danger so close to a new gateway of the world's shipping, submitted a project for the sanitation of Guayaquil port, and a part of the scheme has already been put in hand. The completion of the programme will tend to further focus the country's transport upon the Quito-Guayaquil railway and port, so that it will henceforward be practically impossible, even if it were desirable, to give it a different trend.

The Guayaquil-Quito Railway, which is of 3 feet 6 inch gauge, starts from the Duran landing on the Guayas River, opposite Guayaquil. It is proposed to connect Duran and Guayaquil by a bridge, but at present passengers and goods are conveyed by ferry from the port to the railway terminus. After traversing 87 km. of delta lands the line begins to climb the Andes, and during the next 80 km., using 5 per cent. maximum gradients on a plain adhesion track, attains an altitude of 10,626 feet. The highest elevation of 11,841 feet is reached at km. 275, but the line continues rising and falling between altitudes of 8000 and 11,000 feet, until it debouches on the Quito plateau (9375 feet). The railway is one of the most interesting examples of mountain engineering in South America, the "Alausi Loop" and the "Devil's Nose" double zigzag being especially notable. The last-named section involves the use of a "V" switchback, similar to those employed on the Central of Peru Railway. The ascent opens up some of the finest scenery in the Ecuadorean Andes, Chimborazo and Cotopaxi volcanoes being passed close to the west, their summits high above the snow-line.

Although the Guayaquil–Quito Railway was only completed in 1908 its first concessions date from 1872, and the history of the line is practically an epitome of the progress of Ecuador during the intervening period. An extension is planned from Quito north to Ibarra, towards the Colombian border, and also from Guayaquil to Playas, a port on the Gulf outside the Guayas river bar, and there is little doubt that both these projects will be carried out.

For the present the Guayaquil–Quito Railway serves, and indeed, has anticipated, the chief needs of Ecuador for years to come. The plateau portion of the line is an important link in the much-advertised project of a through railway from New York to Buenos Aires, which under the pretentious title of the "Pan-American" Railway has gone to some expense in making sporadic surveys here and in other parts of South America. Any engineer with even an elementary knowledge of Ecuador's geography, as well as of the physical difficulties facing an extension of the Guayaquil-

Quito road either north or south, must be very doubtful of the practical advantages of this scheme. Meantime there is no good reason, political or economic, to suppose that the railroad system of Ecuador will be employed otherwise than in concentrating all the energy and trade of the Republic upon its existing outlets to the Pacific coast.

COLOMBIA

Although Colombia is the only country in South America whose coast-line faces to both the Atlantic and the Pacific, the three great Cordilleras which split it from south to north, and the position of Bogotá, the capital, in their midst, make this possession an embarrassment rather than an asset in solving her transport problems. Of the dozen or more railways open to public traffic, no single line exceeds 136 km. in length, a fact which is in itself eloquent of Colombia's complex topography.

Most Colombian railways are designed as links with the Magdalena River, which traverses the heart of the land between its attendant mountain ranges. The stream is navigable by shallow-draught steamers for over 1120 km. from the Caribbean, although its course is broken halfway by the impassable Honda Rapids. This invitation of an easy fluvial passage to Colombia's interior by the Magdalena is, however, more apparent than real. The river is bordered in its lower reaches by extensive marshes draining from broken, forest-clad hills, while its upper stream leads straight into a mountainous "cul de sac" culminating in the Nudo de Pasto of the Ecuadorean Andes. There is little settlement on the banks of either its upper or lower stream, for Colombia's chief products come from remote secondary valleys, or are grown on high plateaux. The exclusive use of the Magdalena approach has, moreover, resulted in almost entire neglect of the lands in the Amazon and Orinoco basins, comprising three-fifths of Colombia's whole area, which remain to-day unmapped and uninhabited save by a few rubber traders and Indians. One of the few inland frontiers still disputed in South America lies in the north-west corner of the Amazon Valley, where these neglected hinterlands of Brazil, Peru, Colombia, and Venezuela meet.

All populated Colombia thus lies on a triple cordon of the Andes, which, breaking out from Ecuador, spreads north through the Republic like the ribs of a half-open fan. The lowest passes of the Pacific Cordillera are 3000 feet above sea-level. This, together with the coast, forms the Pacific section of Colombia.

The Magdalena Valley between the central and the eastern ranges, at a point opposite Bogotá, is 7000 to 5000 feet below plateau levels or mountain passes on either hand. The passes leading out of the Magdalena Valley are lower when downstream, higher—almost impassable—upstream. Such is Colombia's Central and chief transport zone.

The Cordillera running east of Bogotá, including that splendid outlier the Sierras of Santa Marta, whose five snow-capped peaks, over 19,000 feet high, marked the Magdalena entrance to early explorers, defines a third

zone, equally apart from the rest. A distinctive feature of this Eastern Cordillera, the highest of the three ranges, are its grassy highlands, occurring from 7000 feet upwards. These savannahs, or "sabanas," are the remains of an ancient plateau, now heavily eroded by tropical rain, and with its deep-cut valleys smothered in tropical forest. Part of this eastern country joins the Venezuelan frontier, where the natural outlet to ocean is through that Republic by the Gulf of Maracaibo, a political factor which has considerably affected its past development.

Split by these great mountain masses into a series of roughly parallel south-and-north zones, no country in South America has made greater sacrifices than Colombia, not only to unite its provinces by an interior railway system with Bogotá, but to ensure to each province, by rail or river, its ocean outlet. The difficulties in the way have proved enormous. Bogotá stands 8563 feet high upon one of the saucer-like eastern savannahs mentioned, about 150 km. east of and 1200 km. upstream from the Magdalena delta. Any western railway that connects the capital with the Pacific coast will thus resemble a gigantic switchback, with five separate descents and rises ranging from 7000 to 3000 feet each. Constructions eastward are limited by Venezuela's control of the Gulf of Maracaibo. While these more settled portions of the Republic are yet insufficiently served, Colombia's territory in the Amazon basin will remain, like that of her neighbours, untouched by the railroad for long years to come.

The bulk of imports and exports in Colombia both comes and goes by way of the Magdalena River, excepting always the local banana traffic direct to the Caribbean of Santa Marta port. The railways which at different points throughout its course link Bogotá with the Delta, are an earnest of the nation's choice of this as their permanent and main passage to the outside world. Colombia's capital city is more remote to modern travel than any other South American capital, about a week being employed on the inward trip by the Magdalena, and five days to return. As all ordinary travellers, in addition to goods, must approach and leave Bogotá by this route (unless they venture on mule-back over the mountains), a detail of the various stages may be usefully given here. In all five changes are made, viz.—

Route from Ocean to Bogotá, Colombia.

		Length of sections in km.
Savanilla Bay to Barranquilla (Magdalena River)	Barranquilla Railway, 1 metre gauge	37
Barranquilla to Dorada	Colombia River Navigation Co.	about 864
Dorada to Ambalema	La Dorada Railway, 3 feet gauge	111
Ambalema to Girardot	Colombia River Navigation Co.	about 70
Girardot to Facatativa	Colombian National Railway, 3 feet gauge	132
Facatativa to Bogotá	La Sabana (State) Railway, 1 m. gauge	40
	Total, Barranquilla to Bogotá	1,254 km.

If the journey is begun from Cartagena port, the distance remains almost the same, an additional 71 km. on the Cartagena Railway being balanced by a similar deduction from the river trip.

A separate examination of these links in Colombia's sole highway to the ocean will best enable us to gauge their relative value.

The Barranquilla Railway connects Savanilla Bay, on the Caribbean coast west of the Delta, with the small port of Barranquilla from which it takes its title, situated at the lowest stage downstream on the Magdalena River proper. The line avoids the dangerous bar and shifting sandbanks which mask the river's outlet to the Caribbean, and thus affords incidentally one of the best examples in South America of combined rail and river transport work. The Barranquilla was Colombia's first railway, commenced in 1867. No line has played a more useful part in developing Colombian commerce, and it still carries about 70 per cent. of the total tonnage handled at all Atlantic ports (save Santa Marta) for the interior.

The Cartagena Railway serves the same purpose as the Barranquilla line, but crosses from the coast to the Magdalena River higher above the Delta. In addition to its railway the company operates a fleet of thirty-two river steamers, touching at some fifty small ports and landing-stages on the Lower and Upper Magdalena. Cartagena, its railway terminus and ocean port, was prominent even in early colonial days not only on account of its fine natural harbour, but by reason of a canal 132 km. long, engineered by the early Spaniards between the port and the Magdalena. Cartagena was thus enabled for two hundred years to control the entry to the whole Magdalena Valley, in addition to being the chief *entrepôt*, on the Atlantic side, for the trade which crossed by Panama from the Pacific coast. After Colombia's independence was declared the canal, whose course is still visible in a series of shallow lagoons, was allowed to silt up. When in later days the Barranquilla Railway was built, the population of the once-famous port had fallen from 30,000 to 8000, an interesting example of the dependence of South American cities on transport routes, which are essential to their permanent growth.

The *Dorada Railway*, built round the Honda Rapids of the river, forms the connecting link between navigation on the Lower and Upper Magdalene. It therefore of necessity handles all imports and exports for Bogotá and for the interior country above the rapids. Operated by an English company, it lies on the left bank of the river and is the best maintained and equipped line in Colombia. The railway has the right of extending from its present up-river terminus at Ambalema to a point opposite Girardot, the gap of 60 or 70 km. being at present covered by the river steamers of the Carthagena Company. In the event of the Doradá line linking up with the Girardot railway and so providing through railway connection between the lower river and Bogotá, it would still be necessary to first build a bridge over the Magdalena river, in itself a formidable undertaking. Periods of low water, which already interrupt

traffic on the Upper Magdalena, have a marked tendency to recur as forests are denuded or burnt near the headwaters of the river, and the rail extension from Ambalema to Girardot thus tends to grow more urgent each year. From Mariquita station, where the line curves inland past the rapids, an aerial railway, or ropeway, has been constructed to Manizales, a fertile coffee and mining centre lying among the hills 64 km. due west of the line. The only other aerial railway, to my knowledge, open to public traffic in South America, is that serving the Famatima copper-mines in the province of Catamarca (Argentine). The success achieved through the construction of similar overhead cableways, officially known as "Telleferica" by the Italian Army in their present campaign against Austrian troops among the Dolomite Alps, may later lead to an extension of their use in South America. Such lines are not of course best suited for passengers, but by their relative cheapness, direct access, and quick construction they would help to secure mining and other traffics equally essential to the prosperity of many a struggling enterprise among the Andes.

The Colombian National Railway, known locally as the Girardot Railway, runs from Girardot port on the Upper Magdalena (altitude 1066 feet) to Facatativa (8576 feet) on the western edge of the Bogotá savannah, thus rising 7510 feet in 132 km. The maximum gradient is 4 per cent. and no racks are used. Though not situated on the sea-coast, the Girardot Railway falls into that category of politico-mountain railways giving an ocean outlet to the capital city, which includes the La Guaira–Caracas Railway of Venezuela, the Arica–La Pas Railway of Bolivia, and the Guayaquil–Quito Railway of Ecuador. Construction on the Girardot line began in 1880, but faulty surveys, political troubles, and lack of funds delayed its completion for twenty-seven years, until August 1909. At one difficult period the Government lent military aid to carry on construction, and though registered as an English company the line has always been recognized as a National rather than a private enterprise, as its name implies. The total cost to the Government has been over £1,500,000, but the result has been to barely establish the rail connection. Before the line can bear heavy and continuous traffic it will practically have to be rebuilt.

La Sabana Railway.—This last link in the long chain from the Delta to Bogotá merely covers the 40 km. of flat savannah which separates the capital from the steep edge overlooking the Magdalena valley. Apart from this, the Sabana Railway is noteworthy as having been built and operated on the Bogotá plateau long before the Girardot railway was complete. This amazing feat was accomplished by carrying all the heavy railroad material, including rolling stock, by cart and on mule-back up from the Magdalena River by a road specially constructed from Cambao port (opposite Ambelema) to the plateau. The expense of this rough mountain road was £7500 per kilometre—equal to that of a first-class,

well-ballasted, broad-gauge railway near Buenos Aires. As if to perpetuate its early independence the Sabana line, being of 1 metre gauge, obliges all goods for Bogotá brought up the 3-feet Girardot Railway to be re-handled at Facatativa.

The Cauca, or Pacific Railway, will connect Buenaventura, the chief Pacific port of Colombia (410 miles south of Panama), with the valley of the Cauca river. This line represents the first stage in an ambitious project for joining Bogotá to the Pacific coast. The Cauca valley, its immediate objective, is fertile and well settled; its mining industry achieved in 1915 a gold recovery totalling close on a million sterling. The Pacific Railway was started in 1876; but after a lapse of thirty-one years only 55 km. had been built, including a bridge connecting Buenaventura Island with the mainland. Here, as with the Girardot line, owing to unsettled conditions and interrupted construction the loss of time, energy and money was enormous, and the total cost to Colombia of these 65 km. is around £1,000,000. In spite of this outlay the line fell into dangerous disrepair. A frank statement by the Ministry of Public Works in 1912 adduces, as a proof of improved conditions, that whereas in 1910 there were 162 derailments on the line, in the succeeding year derailments fell to only 70. The distance from Buenaventura to Cali, the present inland terminal situated on the Cauca river, is 125 km., the coast Cordillera being crossed at 5216 feet by the Cresta de Gallo Pass. Shortly after construction reached this point in 1913 violent rainstorms washed away large portions of the newly-built track, which however has since been repaired. The rail altitude at Cali, within the valley, drops to 3300 feet.

Stress has elsewhere been laid on the immense difficulties that attend all railway building in the rainy tropics of South America. Colombia's costly attempts at mountain railway construction call for careful study rather than cheap criticism. The lessons they bring home for our guidance in future work here and elsewhere are (1) to estimate liberally for *unforeseen* difficulties; (2) to make full provision of funds, material, and labour before starting; and (3) having started, to push the construction to a close with the maximum energy and in the shortest time possible. Nature when waging warfare is more implacable than man, and in these isolated regions of the Southern Continent the silent struggle is unequal and unceasing.

VENEZUELA

Although an eastern counterfort of the Andes projects upon its coast and its southern frontier touches the water-parting of the Amazon, the major part of Venezuela's internal transport system is safely beyond the control of these two dominant factors in South American geography. In other respects this northernmost of the Republic presents us with a small-scale replica of Brazil. A coast plateau presents its abrupt cliffs to the sea. A shore-line clothed in dense vegetation reveals unexpected harbours.

Its western watergate, the Orinoco, is divided into an upper and a lower basin and offers 1200 miles of river navigation from the Atlantic, with vast plains and savannahs stretching on either hand. Yet though nearest to Europe of all South American Republics and having attracted to its territory in consequence more than its share of early exploration * and settlement, Venezuela, with over 1,000,000 square km. of territory and nearly 3,000,000 inhabitants, can to-day show only 938 km. of railway.

The early founding of Caracas, on the coast plateau at 2984 feet altitude, overlooking La Guaira port, also definitely fixed upon the Caribbean coast the later political control of the Republic. The effect of this control has been disproportionately marked. All settlement is concentrated north of the Orinoco basin, within a zone nowhere over 150 miles from the coast, and every kilometre of railway in the country lies on this narrow strip of territory, leaving the 370,000 square miles within the Orinoco basin practically undeveloped. Venezuela's present transport service is not only inadequate to the needs and resources of the country; it both unbalances and accentuates an uneven development. The position of Caracas made a rail connection with La Guaira port the first necessity, its costly construction being later duplicated by the Puerto Cabello–Valencia line further west. Constructions upon the Caribbean coast naturally followed the river valleys as much for the sake of gradients as to serve existing settlements along these valleys. In a country of heavy rainfall this led to abnormal expense in bridge work. On the 938 km. of track in Venezuela there are over seven hundred bridges, and this heavy expense again helped further to exhaust the resources available by Government to aid new constructions. Some twelve years ago Congress recognized the unsatisfactory position by passing its first railroad law. This hastily coded statute had the undesigned effect of stopping all new construction, and has since been drastically revised. It had however one good point, viz. the limitation of all new lines to a uniform 3 feet 6 inch gauge. The only other South American state which legally enforces a uniform gauge is Bolivia, where the ruling standard is 1 metre.

Just as in Brazil the loop of line connecting Rio and Santos ports is from every viewpoint the most important in the country, so the similar loop from La Guaira to Caracas, across the Valencia plateau and down again to Puerto Cabello, is Venezuela's key-system. It has the added advantage

* *Vide* "The Discoverie of the large, rich and bewtiful Empire of Guiana, with a relation of the Great and Golden City of Manoa (which the Spaniards call El Dorado) And the prouinces of Emeria, Arromaia, Amapaia, and other Countries, with their riuers, adioyning. Performed in the yeare 1595, by Sir W. Ralegh, Knight" (Hakluyt Society Edition, 1848). The Guianas to which Raleigh referred were of course the southern highlands overlooking the valley of the Lower Orinoco. His entry to the river was effected by the "Bocas Chicas" or western mouths of the Delta, which are only 30 miles distant from the shores of the British Crown colony of Trinidad.

of epitomizing for the traveller in the space of a short and convenient trip, certain picturesque aspects of South America which elsewhere would take him several weeks to encounter.

La Guaira–Caracas Railway.—Although the distance between the historic port of La Guaira and the capital city is only 11 km. as the crow flies, the railway develops a total length of 36½ km. in order to climb the abrupt scarp of the plateau, which it achieves on a maximum 4 per cent. grade without the use of racks. The line ranks high both in interest and utility among the other remarkable coast-to-mountain railways of South America. Like the Paranagua–Curytiba line in Brazil, it skirts in the ascent an abyss varying up to 1000 feet in depth, whence magnificent coast views are obtained. The highest altitude (3320 feet) is reached just before the descent to Caracas. The railroad was commenced in 1880, and construction finished in 1883, a fact greatly to the credit of the English Company which operates it.

The Great Venezuelan Railway acts as the connecting link along the coast plateau between the two port lines of La Guaira and Puerto Cabello. The line traverses a very broken country and its 179 km. include 219 bridges and 86 tunnels, thanks to which it keeps within a 2 per cent. maximum gradient. This is one of the best built and maintained lines in Venezuela, and carries more passengers than any other, a further proof of the concentrated settlement on this coast plateau. Through its eastern and western terminals at Caracas and Valencia it feeds the La Guaira and the Cabello port lines, though traffic destined for the former is handicapped by the break from 3½ feet to 3 feet gauge. The Great Venezuelan Railway was built and is to-day operated by a German company, whose control is in Berlin. The only other railway (a term which does not include suburban and city tramlines) in South America in German hands is a line in Sta. Catharina (South Brazil), leading inland from Blumenau. It is significant of the interest taken by the German Government in the business engagements of its overseas citizens in South America, that when the contract for the Blumenau railway was concluded, Emperor William II. presented a signed portrait of himself to the German minister who helped to negotiate it. Again, in Venezuela when in 1897 serious differences arose between the promoters of the Great Venezuelan Railway and President Castro's Government, German warships were ordered to Caracas to try and force a settlement.

The Puerto Cabello and Valencia Railway starts, as its name indicates, from Puerto Cabello (a sheltered harbour 120 miles west of La Guaira), and after a short coast run turns up the valley of the Aguacaliente river and reaches La Entrada (1952 feet), climbing 1730 feet in 15 km. A maximum gradient of 8 per cent. for 4 km. when approaching La Entrada is surmounted by rack-rail.

Western and Frontier Lines.—The oldest railway in Venezuela is the Bolivar (176 km.) from Tucacas port to the rich copper-mines of Aroa.

In its final ascent to the mines the railway negotiates 2 km. of 5·27 per cent. gradient on an ordinary adhesion track.

Several short lines serve the Maracaibo district, which has much increased in importance owing to recent discoveries of oil. Maracaibo Lake—as large as Lake Erie—lies on the extreme western front of the Republic, which is hemmed in by the Colombian Andes. The Lake connects through a narrow sea-channel with Maracaibo Gulf, and forms the only natural ocean outlet for all lines lying within this last fork of the Andean ranges.

Here also we find the *Tachira Railway* (115 km.), which in a commendable spirit of economy begins some 50 km. up the navigable Catatumbo river, skirting the Colombian frontier. *The Cucuta Railway* in Colombia (71 km.), which is completely shut off by the Eastern Colombian Andes from the rest of that Republic and depends entirely on its Venezuelan outlet, also connects with Maracaibo navigation at Encontrados, near the junction of the Catatumbo and the Zulia streams. The two frontier railways are not yet joined up, though a link of about 20 km. would not only obviate river delays on the upper Zulia, but inaugurate the first and only international railway service likely to operate out of Colombia or Venezuela. By pure coincidence both railways are also built to the same gauge, viz. 1 metre.

The Orinoco Basin.—The most obvious lack in Venezuela is a railway leading from Caracas due south over the coast hills and down to the Orinoco River. A start of 66 km. in this direction has been made by the Venezuelan Central Railway, but being operated by a private company its means are too limited to undertake extensive pioneer work through an undeveloped country, whose only present industry consists of vast cattle ranges. Properly backed by the Venezuelan Government, a trunk railway to the Orinoco, short-circuiting the present roundabout sea and river route *viâ* its Delta, would have the same effect on the whole neglected Orinoco basin that a ventilating shaft has on a closed mine.

The Orinoco must in the end always exercise a major influence upon Venezuelan transport. Too great to be bridged, its navigable reaches, like those of the Amazon, will have to be combined with and by the railway. Torrential rains cause the main river to rise at times 30 feet, and in the narrower passages 50 feet, but these variations somewhat counteract the difficulties of the passage for large vessels trading within the Delta channels, where the river's minimum depth, according to season, varies from 10 to 15 feet.

As the Orinoco leaves its upper basin it drops through 6 miles of rapids known as the Raudales de Atures. The building of a short loop line here, linking traffic on the upper with that of the lower river, would have the same relative strategic value to this Guiana hinterland* as the

* The expression is here used in its wider sense of water-parting with the Amazon basin.

Madeira–Mamoré Railway has to the Madeira watershed of Eastern Bolivia and the lower Amazon River. At the extreme limit of the Orinoco, on the Brazilian frontier, the catchment phenomenon known as the Cassiquiare Canal permanently unites the headwaters of the Orinoco to those of the Amazon *viâ* the Rio Negro.* Allowing, therefore, for portage round the Raudales de Atures rapids, continuous river navigation is feasible from Bolivar town on the Orinoco to Pará at the entrance to the Amazon, a distance of over 2500 miles.

Studying these immense inland waterways we find that a combined rail and river route, joining Caracas to Buenos Aires, is not outside the limits of possible transit. Apart from any local advantage, such a system would at least demonstrate that most remarkable and much-neglected feature of South American geography, namely, the continuous and low-level river-basins which run through the heart of the Continent. It would be possible to traverse on an inland voyage from Bolivar (Lower Orinoco) to Buenos Aires over 6000 km. of continuous though tortuous river navigation, by utilizing only three link railways, totalling between them 900 km. These links would be, first, the Raudales de Atures portage; second, the Madeira–Mamoré Railway (already built); and third, a further line (already surveyed) from Santa Cruz, the head of navigation on the Mamoré (Bolivia) river, to Corumba, the Brazilian port on the Alto Paraguay. If we add to these the Caracas–Orinoco valley railway construction here recommended we obtain, by the simple and fascinating process of drawing thick lines on a small-scale map, a Transcontinental north-and-south, rail-and-river system at least equal in interest, and with as much likelihood of being carried to completion, as most of the Transandine and Transcontinental concessions which are so light-heartedly applied for and granted throughout tropical South America.

THE GUIANAS

British, French and Dutch Guianas are the only foreign-owned territory—unless we include the Falkland Islands—on South American soil. They resemble a tropical island flung against the north-east shore of South America. Were the continent to be submerged 1000 feet, they would look across the encircling floods of the Orinoco and the Amazon basins to the outlying Andes and the plateaux of Central Brazil. Indeed, the Colonial policy which governs the fortunes of these European dependencies is already as divorced from the ideals of the South American Republics as if some such cataclysm had actually occurred.

British Guiana, the largest of the three Colonies, is about the size

* The same phenomenon of a canal passage joining the waters of two big rivers may be remarked in the Paranacito, which connects the Paraná and Uruguay rivers across the Entre Rios Delta. Although the connection is made at the base and not at the head of the streams the action is the same, the canal flowing alternately towards the one or the other river, according to the flood or fall in either.

of the United Kingdom. The momentum of Georgetown, the capital, at the mouth of the Demerara river, combined with the vested interests of sugar-plantations along the seaboard, has confined settlement to the flats stretching from the coast-line to the feet of some old forest-covered sand-dunes, about 30 miles inland. On the sea side these coast flats were protected against high tides by an embankment built by early Dutch settlers, and practically all the progress achieved in British Guiana since those colonial days has been confined within these two parallel sandheaps. Though 8 km. of the Demerara Railway was the first complete section of railway (1848) built in South America (see Table E, Peru), British Guiana sixty-eight years later can only point to a total of 152 km., and thus takes its place, with the French and Dutch Guianas, among the most backward of all the South American States in enlisting the assistance of modern transport to open up its territory.

Behind the coastal dunes the land rises, and two minor ranges, or rather plateaux descending from the frontier, cross the middle of the colony from east to west. On these uplands the forest, which covers seven-eighths of British Guiana's entire surface, gives way to small patches of open savannah. It is upon the Brazil frontier, however, formed by the Acarai highlands which mark the water-parting between the coast and the Amazon streams, that the largest stretch of open country occurs. It is the considered opinion of many competent observers—an opinion irresistibly backed by all the three hundred years of European experience in South America— that the true centre of British Guiana lies on these healthy highlands rather than on the malarial coast. Proposals have been put forward for a railway linking Georgetown with the Brazilian boundary, which is then less than 500 km. distant in direct line from Manaos, capital of Amazonas, but local administrations have hitherto decided against the project and in favour of timid extensions of the coastwise lines. Had this policy of coastwise settlement been consistently followed in the past,* it might have secured to British Guiana the control of the Orinoco Delta, from which the Colony was finally debarred by recent arbitration, when the Hague Tribunal adjudged this important region, chiefly on the grounds of prior effective settlement, entirely to Venezuela. This gateway to the interior being closed, a coastwise railway is of quite secondary importance to the Colony's future. It may further be safely said that conditions attending the construction of any interior line to the Guiana highlands would be no more arduous, while the chances of successful colonization would be greater, than in the case of two-thirds of the railways built inland from the North Brazil coast. So far the Demerara-Essequibo Railway (31 km. long), due to the enterprise of Messrs. Sproston and connecting respectively the lower and upper navigation on the rivers named, is the Colony's only attempt at an interior line.

* During the Napoleonic wars England occupied the whole coast between the Orinoco and the Amazon Deltas, but at the Treaty of Paris in 1814 only the colonies of Demerara, Essequibo, and Berbice were formally taken over.

With reasonable care and proper selection of breeds, a modern cattle industry on the tropical highlands of the Guianas should be as feasible as it has already proved on the "sabanas" of Venezuela, the "campos" of Piauhy and Matto Grosso, or the open ranges of Central Africa and Rhodesia. The rivers of British Guiana show considerable washings of placer gold to attract the pioneer, while the forest lands, in addition to hardwoods, and especially "greenheart," contain the usual variety of fibrous plants and creepers, nuts, and the other tropical products which are common to all countries facing the Caribbean Sea. The potential water-power of the country must be enormous, though it varies greatly with the dry and rainy seasons. A striking instance of this is given by the Kaietuk Falls on the Potaro River, which make a sheer drop from the central plateau to the coast levels of 741 feet, or nearly five times the height of Niagara. It is a biting endorsement of the failure of European Colonial Administration in South America and of the common sense underlying the Monroe doctrine, that although it is the only British Colony on the South American mainland, despite the impetus given by early exploration, despite its position fronting the North Atlantic, with an uninterrupted mail service and with all England's prestige and wealth behind it, British Guiana should have been more backward in shouldering the pioneer obligations of progress than Paraguay or Ecuador. Happily for our own prestige, British enterprise under a foreign flag in Argentina, Brazil, Chile, and elsewhere has not proved itself so incapable of solving the difficulties, or averse to sharing in the good fortunes which have marked the progress of the South American Republics.

Note.—Since writing the above I have read with much interest the account published in this *Journal* (December 1916) of the journey undertaken by Mr. and Mrs. Clementi to the British Guiana highlands. Speaking with recent and first-hand knowledge, Mr. Clementi's remarks appear to substantially corroborate the premises here set forth. One is at a loss to account, either for the dilatoriness of the local Governments in not earlier establishing a healthy hill station on a location so close to the coast, or for their tardy conversion to the actual geographical facts set before them at different dates by reliable travellers. Apparently Mr. Menzies has already started a cattle ranch at Rupimuni, or Menzies Plateau, thus demonstrating its suitability for live-stock breeding.

This Guiana plateau country is of course not limited to the British Guiana frontier. Although the width of the open pastures is not great, apparently averaging not over 10 miles, their length, owing to the irregularities of the Amazon water-parting, is probably not far short of 1200 miles, stretching from the valley of the Upper Orinoco to within 100 miles of the Brazilian coast.

Dutch Guiana, whose general characteristics resemble those of British

Guiana, has a single line of 140 km. which runs inland and almost due south from Paramaribo, the capital, to Macami on the Surinam River.

French Guiana has no railways, but in October 1913 the General Assembly granted a concession for the construction of a line into the interior, connecting the basins of the rivers Comte, Appronaque, Mana, and Inini.

Conclusions.

We have now completed a hasty survey of the chief transport routes of South America. Let us marshal the facts.

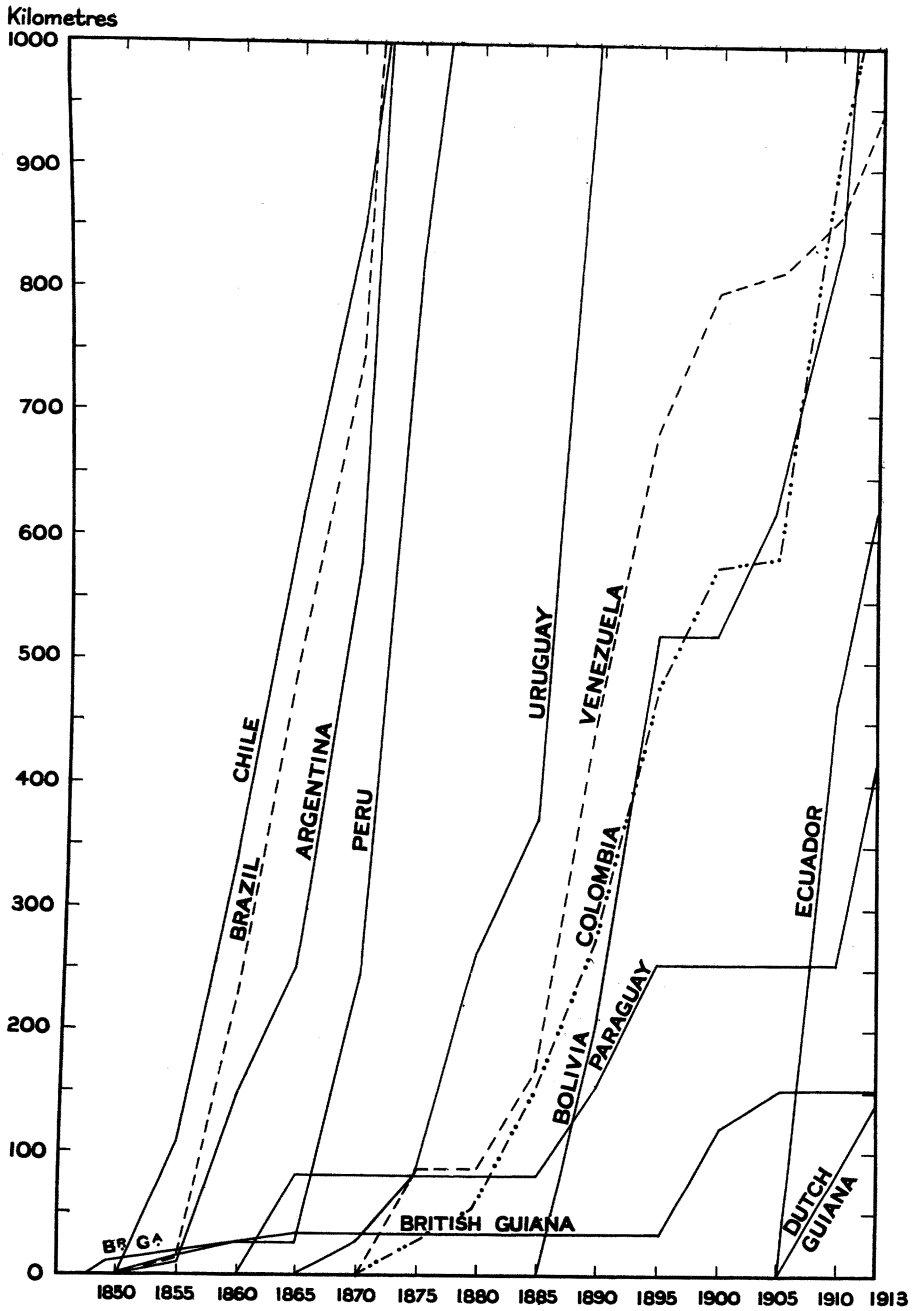
We have seen that over most of South America the difficulties of establishing an efficient transport service are perhaps greater than over any equal self-contained area. The physical obstacles alone are gigantic. State boundaries seldom coincide with purely geographical frontiers. Political control is divided among thirteen self-contained colonies and republics which, in their turn, have granted large measures of local autonomy. The result is confusion in dealing with the transport problems of the continent as a whole, while everywhere we find lacking that co-operation in technical and operating detail, necessary even to local efficiency over any wide area.

Outside the employment of beasts of burden—including man himself—the elements of interior transport in South America are only two, the river and the railroad. Motor transport, although it has been officially attempted in São Paulo State and in Venezuela, must await the construction of proper highways. Rivers on the southern pampas, on the Atlantic coast plateaux, and on the Altoplanicie of the Andes are either few or non-navigable; but in these very regions, where the railway has attained its maximum development, its expansion is due less to lack of water competition than to a healthier soil and climate, attracting immigration and ensuring steady farm production by the free aid of live stock. On the other hand, in the river-basins of the interior—almost entirely uncultivated—navigation is broken by rapids and subject to violent fluctuations of level. The interruption to traffic caused by low water, or (when going upstream) by floods, is equivalent to that caused on the railway by accidents or damage to track; while these hindrances to river transport have the added disadvantage, that they are beyond man's power to control and at times even to foresee. As competing transport facilities are tested by the settler and by Governments, the railway, especially in more temperate portions of the River Plate watershed, tends almost entirely to supersede river navigation. Thus while in the great tropic basins rivers must always provide the major outlet avenues transport in the south and near the coast has cystallized in overland routes, most of which are already occupied by railways.

It is the essence of all sound transportation, by whatever method or route, that while revealing new resources within its zone, it also and chiefly

MADEIRA-MAMORE RAILWAY, BRAZIL

TEMPORARY TRESTLE, MADEIRA-MAMORE RAILWAY



RAILWAY PROGRESS IN SOUTH AMERICA

Showing rate of construction of the first 1000 km.

aims at the elimination of waste. For lack of mechanical equipment the Spanish viceroys in ransacking the mines of Peru "wasted," it is said, eight millions of Indian lives. This same waste, not perhaps of life but certainly of human labour in providing transport, has continued in South America ever since. It is not sufficiently placed to the credit of existing railways that whether successful or not in themselves, they have as a whole certainly more than doubled the efficiency of the all-too-scant labouring population of the Continent.

The task set before the railways * of South America is best illustrated by the efforts they have already made. They scale perpendicular ramparts, searching for foothold like a wary rock-climber, before running out on the Brazilian plateaux. They pant up the flanks of the Andes, bastion heaped on bastion, till at 15,000 ft. altitude they traverse the perpetual tropical snows. They run half smothered in jungle valleys. They link up, circumvent, or surmount rivers often great, always dangerous. They drive across untilled, monotonous pampas that colonists make fertile in their wake; or wind an uphill path to dreary mine-dumps. Their engines burn impartially coal, briquette, lignite, petroleum, hardwood, cow-dung and fungus. Sometimes their road-bed is blasted for miles through solid rock; at others great boulders constantly bombard the track; yet again, especially in Buenos Aires province, stone ballast is regarded as a luxury to be afforded by millionaire railways only.

To the engineer or the student of transport problems, South American

* In dealing with the railway systems which form the chief strategic routes of the South American Republics, mention has purposely been omitted of their tramways. These serve all the more important cities and, when electric power is employed, are the engineers' last word in transport service. The omission may seem the more obvious, since many of the electric lines reckon a kilometrage far exceeding that of the smaller up-country railroads. The electric tramways of Brazil, for instance, with 1200 km., exceed the respective railroad systems of the Guianas, Venezuela, Colombia, Ecuador, and Paraguay, while the single Anglo-Argentine tramway undertaking in Buenos Aires, with 605 km. of surface lines and 14 km. of subway, is valued at a figure which would suffice to rebuild the mountain sections of every Transandine railway on the Pacific coast.

In tramway mileage Rio falls far below the total of Buenos Aires, but it is worth noting that construction of electric tram-lines in or near the Brazilian coast cities, assisted by prodigal water-power, is outstripping similar work in Argentina, where the cost of fuel is a serious item. São Paulo city comes fourth with 226 km., being beaten by Montevideo with 268 km.; but in general it may be said that there is no single country in South America which does not boast its city electric lines, while horse-trams are common in every provincial centre.

There is however one great distinction between the electric tramway and the country railway proper. The former is primarily designed for city passengers; the latter in addition to passengers carries also up-country goods and produce. Tramways are a convenience; if their operation is suspended their unhappy passengers can walk. Colonists and industries settled along the lines of a railway, on the other hand, can depend on the Government to ensure its maintenance for their benefit. I have not wished to extend a survey which is concerned chiefly with these interior routes. Still less do I wish to minimize the important part played by systems dealing with the complicated conditions of city and terminal transport.

railways make the same appeal as the clientele of a great metropolitan hospital does to a doctor. Here may be seen transport undertakings in every stage of development—complete, arrested, or embryonic. Too often a line inherits a weak constitution from its sponsors, but the most common, and almost incurable, defect is bad location due to faulty or inadequate surveys. Nevertheless few railways in South America are daunted by the knowledge, if they ever pause to diagnose it, of their physical or administrative defects. Indeed the adventures of many roads read like the romantic expeditions of the early colonial days; how some prospered and became great and famous, while others failed and perished miserably. The Patillos Railway in the nitrate district, for instance, achieved 80 km. of construction under a running fire of litigation, until it stopped, choked by red tape, 19 km. from its goal. One or two engines and trucks are still standing on the old iron rails, half buried in the desert sands of Northern Chile. The Tolima Railway had its Transandine dreams rudely broken when the Colombian Government, during a political upheaval, hastily commandeered all the rails from its 15 km. of track in order to improvise ironclads on the Magdalena River. The railway drooped but did not quite die, and has lately revived under a liberal vote from Congress. The Sta. Barbara Railway of Venezuela, built in a tropical valley, was abandoned by its original owners after repeated wash-outs from an irrepressible river. It was then leased to a private gentleman who reported lately that, as the river continues to be unmanageable he is maintaining the railway service at these points "por impulso de hombre," *i.e.* by hand-trolley—a very sporting affair. Finally, there was the railway which started up country from a point on the Brazilian coast between the Amazon Delta and French Guiana, without the formality of advising any of the Governments interested. Its general policy and aims were so extremely obscure that, on emerging from their Arcadian solitudes the promotors of the undertaking fell under the ban of high diplomatic circles and the orphaned line * is no longer marked on new maps. On the other hand, turning from the perusal of these romantic records to railway blue-books and Government statistics, we find great State and private systems, the seats of the mighty, whose administrators commune with the European and North American railways as with peers and equals.

In a continent so happily remote from the danger of foreign military aggression the growth of the main inland routes must always chiefly depend on successful settlement. Owing to the colonists' sound preference for the healthier areas, an instinct reinforced by his need for economizing labour, we have seen that settlement has been most successful in the more open

* Mello's Atlas of Brazil (1909 Edition: Pará State) shows a line starting at the Calcoene River and running for 110 km. between "Daniel" and "Lorena," through a country ostentatiously marked "Gold." The railway is not recorded in any of the statistical returns issued by the Ministry of Ways and Communications of Brazil, or elsewhere.

spaces, that is upon the pampas, savannahs, and in upland Andean valleys.

Large areas of such pastures and open park-lands still await effective * occupation by the colonist in South America. They are, in rough order of precedence, that is to say, of desirability: (1) The Argentine foothill country of Patagonia. (2) More or less open cattle country, interspersed by quebracho and mixed forest, in the Argentine, Paraguayan, and Bolivian Chaco, and along the western bank of the Paraguay River as far as the Chiquitos Hills. (3) The cattle country in Matto Grosso, Goyaz, and other States covered by the mid-Brazil highlands. (4) Cattle country in the Orinoco basin and on the Guiana highlands. (5) Sheep pastures on the Andes, ranging from the limit of tree and shrub growth up to the snowline, *i.e.* from 10,000 to 16,000 feet. (6) The hinterlands of Bolivia and the Peruvian "Montana," containing limited areas of pasture set among Amazon jungles. The main routes leading to and from these districts are still unfixed, and will so remain until the pressure of settlement makes its voice heard. Elsewhere in South America the afforested regions present greater obstacles to the settler, not only through lack of labour to subjugate them, but from the difficulty or impossibility of making a free use of live-stock to supplement his efforts. While many interior routes still await definition, however, the majority of the coast outlets towards which they will ultimately trend are already fixed, and will benefit in proportion as fresh settlement extends inland.

It has been the constant pre-occupation of South American Governments, while inviting foreign co-operation, to safeguard the State's right and its freehold in all transport enterprises. Failure at times to hold the balance between State rights and private vested interests has occasioned most of the troubles of foreign-owned transport undertakings in South America. The necessity for properly codifying railway laws is already apparent. Many of the existing laws in force are superficial or obsolete, and permanent Railway Commissions in each State, on the analogy of those acting as impartial umpires in Canada and the United States, will doubtless soon be the rule. More South American Railway Congresses, like that at Buenos Aires in 1910, might do much to promote fruitful co-operation. If they attain no immediately practical result, they at least educate the intelligent travelling and business public, who are mainly concerned, as well as stimulate the backward statistical and survey departments of their respective Governments.

Recent advance, both in the mechanics of locomotion and the technique of survey, has been already much hastened by the lessons of the war. It will be difficult, if not impossible, that such major errors of

* Most of the land referred to, especially in Patagonia, the Chaco, and the Orinoco Valley, has already passed from fiscal to private ownership. Even so it is but scantily grazed. By "effective occupation" is implied roughly the results which would be expected from fenced-in, as opposed to "open range" lands.

railway location as mark, for instance, the Central Railway of Peru and the Transandine line between Buenos Aires and Valparaiso, should be repeated. The wireless telegraph and the use of aircraft and aerial photography will make preliminary reconnaissance in mountainous or forested regions a matter of days instead of months. New methods will certainly be more boldly tried in new places. The extended use of the train-ferry, the rope-railway, of oil burning and internal combustion engines is already assured. The production and use of hydro-electric power, although comparatively recent, is capable of greater expansion in South America than in any other continent. On the other hand, it is a notable weakness that iron ore and coal have not so far been found close to a good labour market, save to a limited extent in Southern Chili, and in consequence the valuable asset of a domestic steel-supply has been withheld.

When the European war ends, the need for a national stocktaking in South America will certainly ensure an energetic "push" in the matter of transport generally and of railroads especially, besides which past developments, however important they seem to us now, will be dwarfed. But while searching out and incorporating new routes and methods of transport, either by land or water, let it be a constant preoccupation both of the State and of the railroads themselves to maintain an ever-higher level of efficiency on the existing lines. Only the railways which run smoothest know how much still remains to be done. Therefore, even while applauding their past heroic efforts, let us counsel a divine discontent. Let us trust, in conclusion, that when the new era of peace arises British Guiana and the other European colonies will take their proper position, as friendly rivals in progress with the native-born South American States.

*Index to Railways mentioned in this paper. An asterisk * denotes British management.*

	km.	page
Antofagasta and Bolivia *	2242	248
Argentine Central * ...	5318	188,192
Argentine Central Northern	2490	191,192
Argentine North-Eastern (Corrientes) *	1210	192
Argentine Transandine *	178	188
Arica–La Paz	463	247, 9
Bahia	1723	169, 176
Bahia Blanca and North-Western *	1341	199
Barranquila *	37	263
Blumenau (Sta. Catharina)	70	173
Bolivar *	176	267
Brazil, Central of ...	1980	171,176
Brazil, Great Western of *	1616	177
Brazil, North-Western of	935	174
Buenos Aires Central * ...	295	193
Buenos Aires Great Southern *	6102	188
Buenos Aires and Pacific *	5689	188, 197, 199
Cartagena	105	263
Cauca	120	265
Chilean State	5151	241, 244
Chilean Transandine * ...	70	245, 6
Colombia National ...	132	264
Cordoba Central * ...	1908	194
Cucuta	71	268
Demerara *	121	270
Demerara–Essequibo * ...	31	270
Entre Rios *	1092	188
Guaqui–La Paz *... ...	101	249
Guayaquil–Quito ...	464	260
La Dorada *	111	263
La Guaira and Caracas *	36	267
La Plata and Meridiano Quinto	551	196
La Sabana	40	264
Leopoldina *	2835	171

Index to Railways mentioned in this paper (cont.).

	km.	page
Lima *	35	253
Madeira-Mamore ...	364	178
Mogyana	1739	175, 176
Paraguay *	376	184
Patagonian	833	200
Paulista	1161	175, 176
Peru, Central of * ...	401	254
Peru, Southern of * ...	862	249, 55, 56
Puerto Cabello and Valencia *	54	267
Rio Grande	2221	173
São Paulo *	247	172
São Paulo-Rio Grande ...	1771	173
Sorocabana	1410	173
Tachira	115	268
Tocantins-Araguaya ...	56	178
Uruguay Central * ...	1575	182
Uruguay Midland * ...	805	182
Venezuela Central * ...	66	268
Venezuelan, Great ...	179	267

Before the paper the PRESIDENT said: At the outbreak of war it was suggested to me that the Royal Geographical Society would have to put up its shutters, or at any rate to give up its Meetings. Fortunately the Council took a different view, and at this moment we are involved in an outbreak of activity I believe quite unprecedented in the Society's annals. Without taking into account Mr. Weston's charming Lectures to Young People, we shall have had in eight days three Meetings of the Society. It may strike some of you as curious that all these three Meetings should be devoted to one Continent—South America. The result is accidental, but I cannot look upon it as inopportune, for whatever may happen in Europe I think there is no doubt that South America is destined to play in coming years a large part in the world's history. It therefore cannot be amiss that we should learn as much as we can of the prospects and conditions afforded by the physical facts of that great continent.

I have said "whatever may happen in Europe." We here can foresee, and believe we are justified in foreseeing, but one result to the great war: the triumph of the Allies. But imagine for a moment the contrary. Imagine the victory of Germany, and the Kaiser enabled to fulfil the ambition which he revealed by calling himself "the admiral of the Atlantic." The Monroe doctrine has at the present moment for its only real safeguard the British fleet. Can we believe that if that fleet were removed any part of the American Continent would be safe from German attack? On the other hand, look to what we trust is certain: a Germany defeated, and deprived of many of her colonies. The Prussian despotism destroyed, there will remain the great German nation, a nation reformed, we hope, as to its worst characteristics, but retaining its better qualities. Such an efficient nationality must in time seek fresh outlets. And where is it more likely to find them than in the districts of South America already occupied by large German communities, which I understand are very prosperous. Do not let me be taken as inviting a political discussion. Our business here is to formulate the facts upon which politics are, or ought to be, based. It is in this sense that any divorce between geography and politics must be dangerous, and, as it has proved in past history, may be disastrous.

With these few words as a prelude I introduce in Mr. Barclay one of the Englishmen who has visited and traversed South America in many directions and knows it thoroughly. He will tell us what are its characteristics and its capacities of future development.

(*Mr. Barclay then read the paper printed above, and a discussion followed.*)

Señor AGUSTIN EDWARDS (Chilean Minister): Before I say a few words upon the interesting lecture we have just heard I wish to thank the lecturer

SOUTH AMERICAN RAILWAYS
Barclay.