CHAPTER VII

COURSES SURVEYED

The following courses have not been surveyed by us but have been copied from the map of MacGillavry: the Carretera Central from Sibanicu to Guaimaro and the course from Marti to Veinte y Uno. The only data which have been added to these courses are three measurements which occurred on Tschopp's map.

From the Carretera 3.7 km W of Cassorro to the N V 234—V 241.

At V 234 and V 235 normal dioritic rocks are found. At V 236 we get the same difficulties as on the next course from Cassorro to the N. From this point to V 240 only noncommittal generally silicified porphyritic rocks are found, which, according to their habit, belong to the Tuff Series, but in the first place; they are not metamorphosed and in the second place, on the above-mentioned course these rocks alternate with fossiliferous Habana limestones. These rocks are provisionally assigned to the Habana Series.

At V 240 a conglomerate is sampled with pebbles of all sorts of volcanic rocks, among which a calcitized tuffite with Radiolaria. This conglomerate is believed to be the basal conglomerate of the Eocene, which view is based on the following facts: 1. N of this locality, at V 241 and V 241—a, eocene rocks have been found. 2. To the E at loc. V 187, similar pebbles have been found lying all over the country, among which a tuffite with Radiolaria and quartz splinters, so obviously a Habana-rock.

As already mentioned at V 241 and V 241—a eocene rocks have been sampled; they are limestones with Radiolaria, sponge needles and Globigerina, in one case with Gammelinia. These rocks are identical with rocks which MacGillavry sampled at L 692-b to the W, which have been assigned to the Eocene because they are very slightly folded and Habana rocks in this part are always very strongly folded.

It must be noted that to the W in the adjacent area, MacGillavry assigned the rocks between diorites and Eocene to the Tuff Series. This was mainly based on sample L 692—a, again a rock which habitually should be assigned to the Tuff Series, but through silification has become non-committal.

From Cassorro to the N.E. V 219—V 233.

Till V 224 dioritic sands are found, with occasionally more resistant rocks, which, with the exception of V 219, a porphyritic amphibole-quartz-diorite, all appeared to be amphibole-quartz-diorite porphyrites. That these rocks
belong to the diorites is made probable by the fact that they occur amidst diorite sands, and by the fact that their groundmass is much coarser, and the groundmass-felspars are much more thick-set than the generally slender felspars of Tuff- and Habana Series. But in the case of H 222, where the groundmass is very fine-grained, no essential difference is found with corresponding rocks of the Habana Series.

At V 223 the sand grains of the soil become much smaller and at V 224 a porphyrite penetrated by heulandite is found, followed at V 225 by an augite porphyrite tuff. The position of these rocks is uncertain as their habit points to Tuff Series origin, but against Tuff Series and for Habana-age the following facts are presented: 1. the rocks are devoid of any sign of metamorphism; 2. later on this course comparable rocks are found to alternate with fossiliferous Habana limestones. These rocks have been assigned to the Habana Series, as a Tuff Series-age would involve complications, which cannot be taken into account at this stage of our knowledge of this part of Cuba. Proceeding, at V 226 and V 226a amphibole diorite porphyrites are sampled. Here again the soil is sandy. At V 227 two samples of porphyrites offer the same difficulty as those found at V 224, 225. These have also been provisionally assigned to the Habana Series. Then at V 227a again an amphibole diorite porphyrite has been sampled. Certain Habana is found at V 227b where a limestone with Pseudobitoidea and Scolopercula has been sampled. After this locality till the end non-committal porphyrites and tuffs have been found, alternating at V 228a with limestones with Pseudobitoidea and Barretia monilifera Woodward and at V 230 with conglomeratic limestones with small volcanic pebbles and Pseudobitoidea. In one of these limestones quartz veins occur, which proves that secondary quartz was also supplied in or after Habana-time and thus silification may not be taken as evidence for Tuff Series-age. E of V 228a a low ridge has been observed, striking about N. 90 E. It must be noted that on these courses, rocks have been assigned to the Habana Series, which elsewhere should have been assigned to the Tuff Series. Here, however, two data, namely the lack of metamorphism and the alternation with Habana-limestones supported an Habana-age.

_Palo Seco-Marti, along a railroad. W 223—W 230._

Up to W 229 only rocks of the Diorite Series occur. Here syenitic rocks are found, to wit: W 224 a syenite, W 226 a syenite aplit and W 228 again a syenite aplit. W 223 and W 225, albitites containing orthoclase, represent mineralogical transitions to granitic rocks. W 223a and W 227 are a quartz-diorite porphyrite and a quartz-diorite aplit. From a point about 1400 m after W 223, 1½ km to the south, hills could be observed, probably consisting of rocks of the Tuff Series. This fact was taken into account while constructing the map. At W 229 a quartz porphyrite breccia is sampled, which is thought to belong to the Habana Series, because it contains a quartz phenocryst. This view is sustained by the fact that at Loc. W 230 crystalline limestones are found with Rudist fragments, thus belonging to the Habana Series.
These have also been observed by MacGillavry on the Carretera Central at Marti, V 499—501, striking N 70 E, dipping 20 N.

From Guaimaro to the North. V 173—V 189.

This course has already been surveyed in 1934 (lit. 5, V 427—V 446). Any discrepancy which exists between our results and those of MacGillavry will be discussed.

Starting in the diorite massive of Guaimaro, after 1200 m a uralitisied augite porphyrite breccia is sampled on a small hill V 173, followed at 1450 m by a porphyrite tuff V 173a. As these rocks undoubtedly belong to the Tuff Series the boundary Diorites—Tuff Series has been drawn at 1200 m. These last rocks must have escaped the notice of MacGillavry who has drawn the boundary at 2300 m from the starting-point, coinciding with our sample V 174, a uralitisied porphyrite tuff. It must be noted that V 173a does not show any trace of uralitisation, which is rather striking as all other Tuff Series rocks on this stretch have been more or less uralitisised. Up to V 177, a quartz-diorite porphyrite, only Tuff Series rocks have been sampled. MacGillavry, however, found two outcrops of dioritic dyke rocks at about 100 and 300 m after V 175b. I consider these rocks as dioritic dykes intruded into the Tuff Series and not as parts of a small massive as appears from MacGillavry’s map. The arguments which sustain this view are the following: 1. between the aforementioned dyke rocks and V 177 we sampled V 176, an epidotised and uralitisied porphyrite. This might be an inclusion in the diorites, as probably occur elsewhere, but, 2. no mention occurs, neither in our notes nor in MacGillavry’s, of a sandy soil which nearly always covers dioritic rocks of some extension. These arguments also go for V 177. 300 m further on V 177a a uralitisised diabase porphyrite with plagioclase phenocrysts up to 1 cm was found. This rock is identical with V 333. V 178 marks the beginning of a large diorite massive, continuing up to some distance before V 181. Some samples were taken, generally of hypabyssal origin or marginal facies, which are better proof against desintegration than the mother rock. V 179, an aplitic syenite must be mentioned separately. These rocks occur on a larger scale on the adjacent course W 223—W 230. At locality V 181 a green rock has been sampled which unfortunately got lost. These green rocks are reported to persist 300 m where they are sampled again and appear to be uralitisied tuffs, V 182. Accordingly, the boundary Tuff Series—Diorites has been drawn before V 181. 50 m before the cross road, again dioritic rocks are reported in our notes, but no sample was taken. MacGillavry has sampled these rocks and they appear to be porphyritic breccia’s and porphyrite tuffs with no trace of uralitisation. These rocks are said to persist 200 m, forming small hills. Then, at loc. V 183, a porphyritic quartz diorite has been found. On the cross-road to the E at first two non-uralitisised rocks were sampled, one a gabbroid rock, the other a porphyrite tuff. After 1050 m from the crossing, diorites occur, which have not been sampled. V 189b again is a non-uralitisised porphyrite. V 189c, on the other hand is rather strongly uralitisised. After 2700 m from the cross-roads
large diorite blocks are reported at 100 m N of the road, which after 300 m are observed in the river-valley: V 189e, f, g all amphibole quartz diorite porphyrites, in contact with V 189d, an uralitised porphyrite. Proceeding on the main road from V 183 to V 186 only dioritic rocks were sampled. The soil occasionally appears to consist of an arenaceous clay. It is possible that it is derived from sediments but as no further particulars are available it is mapped as diorite. At V 187 many siliceous pebbles are found among which quartz porphyrite tuffites with Radiolaria from the Habana Series. These pebbles are considered to form part of the Eocene basal conglomerate as also found near V 240 on the course NW of Cascorro. MacGillavry does not mention these pebbles.

I still have to mention a rather conspicuous hill La Descada, which could be observed to the W of the cross-road near V 182. On Tschopp's map it has been indicated as a limestone hill.

*From Guaimaro to the South.* H 136—H 150.

We start in the diorite massive of Guaimaro. At loc. H 137 two samples were taken of rock fragments which were lying all over the country. These rocks consist of labrador-andesine and amphibole with much magnetite and some heulandite-veins. The texture is in one case porphyritic: lath-shaped felspar phenocrysts and a groundmass of felspar and green amphibole, in the other there is only one generation; this rock looks like a dyke rock. As we are very close to the contact with the older Tuff Series, we may not exclude the possibility that we have to do with a melanocratic marginal facies of the diorite, a view which is strengthened by the mode of occurrence as described above. Further on the typical sandy diorite soil makes place for a grey clayey soil. At loc. H 138 uralitised augite-porphyrite-breccias have been sampled. Up to H 140 we find direct evidence of contact-metamorphism: uralitised rocks, and garnet-epidote rocks, the latter probably originating from limestones.

At loc. H 140 on a ridge we again find uralitised porphyrites together with quartz-sericite rocks. Proceeding, at H 141 quartz-prehnite rocks were met with. At loc. H 142 it appears that these mineralised rocks originate from porphyrites, as the texture is still distinctly porphyritic. The constituents, however, are all changed to sericite and quartz or sericite and limonite. H 143 and H 144 again furnish normal Tuff Series rocks: augite-porphyrite, subsequently epidotised or chloritised. At H 145 the mineralised rocks appear again: a quartz-prehnite rock and an amygdaloidal porphyrite, totally silicified and calcitised. Till the end of this course only normal Tuff Series rocks are found: augite-porphyrites more or less weathered. Going back we find at H 150 a white sterile marl, which seemed to be resting upon the Tuff Series but it is not impossible that it is intercalated. With the exception of this last sample it is certain that after H 137 we have only to do with Tuff Series rocks, metamorphosed and mineralised near the diorite-contact. Two questionable strikes have been measured which, however, suit very well into the general plan.
Santa Lucia-Guaimaro. H 244—H 256.
On this course only Tuff Series rocks are found.

Santa Lucia-Quatro Caminos. F 234—F 236.
On this course only Tuff Series rocks are found. It is here that we find an alternation of volcanics rocks and the Provincial Limestones, proving that the latter are intercalated.

From St. Lucia by Veinte y Uno to sugar mill San Francisco.
H 218—H 243; T 1093—T 1097.
From Veinte y Uno to the South this course has also been surveyed by Tschopp and the Cuba expedition 1933. Whenever our results deviate from or can be amplified by theirs, this will be discussed. Strikes and dips from Tschopp are indicated with a T, those from MacGillavry are omitted.
From Santa Lucia to Veinte y Uno only Tuff Series rocks are found. The last real Tuff Series sample is taken at H 225. From this point to Veinte y Uno our notes report: "from this point to the road porphyrites". From Veinte y Uno to the south the sample at H 226 appears to be an amphibole-quartz porphyrite, so indubitably Habana Series.

It is seen that it is impossible to indicate the exact boundary Habana Series—Tuff Series on our course but as MacGillavry found the boundary slightly N of Veinte y Uno, it is probable that here it is situated E of Veinte y Uno. At H 227 conglomerates start to crop out, which are held to be the basal conglomerates of the Habana Series. Comparable rocks have been found on course R 165—R 174 and probably at W 256—W 264 and H 287. The pebbles consist of normal Tuff Series rocks and the cement consists of amphibole-diorite material, large and fresh basic felspars (andesine-labrador) and green and brown amphiboles, both with hardly rounded edges. Also augites occur which may originate both from augite-porphyrites or from basic differentiates of diorites. This material is cemented with calcite. The origin of these rocks is difficult to imagine. Tuff Series pebbles must have got unto a sandy beach consisting of disintegration products of amphibole diorites the other way round. The most obvious solution seems to be that the contact of the batholith with Tuff Series rocks was exposed and the Habana sea had transgressed to that point. The difference of resistance against the waves must have determined the relative position of the elements in the conglomerate. But strongly against this view points the fact that among the Tuff Series rocks no trace of metamorphism is found. If this possibility is rejected in connection with the unmetamorphosed state of the Tuff Series pebbles, there are two other principal possibilities left:

1. The beach where the conglomerate was formed was situated on the anomalous contact of the two formations.
2. The Tuff Series pebbles or the diorite sands have been transported to the beach.
COURSES SURVEYED

For the former view there are no indications whatever, and one always hesitates to accept a view which would have such an important bearing on the general tectonics, as in this case overtrust would be involved. As for the latter view, we can easily reject the possibility of transport of the Tuff Series pebbles, as they are too big (diameter up to 20 cm). So the only possibility seems to be that on a Tuff Series coast diorite sands were supplied on a large scale.

Such conditions can only be fulfilled locally, which is in accordance with the fact, that in one of the other places (R 156—R 174) where the conglomerates are found, the dioritic character of the cement makes way for Tuff Series material. Proceeding, at H 228 and H 229 again conglomerates are sampled.

To the W. a hill is observed, with off-shoots to the S.W. (In our notes the way leading up to the hill is to N 320 E, but on MacGillavry’s map and on the one from Tschoopp it strikes to about N 270 E, which is accepted as the right azimuth). The hill at H 230 appears to consist of Habana limestone with many Rudists. It contained very large and beautiful caves in which one could easily lose one’s way. Proceeding on the main road, till H 236 typical Habana rocks are sampled: tuffs with quartz-fragments and in one case with numerous Glaebelinas. The samples from H 232 and H 234 do not contain quartz, but as in both cases at the same spot also quartz-bearing tuffs are found; they obviously belong to the Habana Series. Then at H 236 an opalised porphyrite-tuffite is sampled, which is followed again by well stratified tuffs quite comparable to the Habana tuffs as sampled before. Therefore H 236 has also been assigned to the Habana Series. Then at H 237, 238 and 239 we sampled opalised augite-porphyrites, which manifestly belong to the Tuff Series. At this point the correlation with the results of the other surveys is rather difficult. MacGillavry has left the stretch between H 237 and H 241 undetermined. Tschoopp however has sampled T 1094 (T 1093 is lost): an Habana limestone with quartz splinters and has sketched in a couple of strikes and dips till a place 1 km beyond the beginning of our „Tuff Series“. Two solutions are possible: 1°. our samples do not belong to the Tuff Series but to the Habana, a view which is supported by the fact that in our notes these samples with the exception of H 239 are recorded as „agglomerates“ just as the conglomerates from H 227—H 229. The samples, however, do not reveal anything of the kind. Still it is possible that only fragments of pebbles have been sampled. In that case we would have attained the base of the Habana, again followed at H 239 by real Tuff Series. 2°. Tschoopp’s surveys have not been sketched in at the right places. This is the most plausible solution as all the stratified rocks beyond H 237 could hardly have escaped our attention. Tschoopp’s strikes and dips have been sketched in on our map on the base of their distance to the bend of the road between H 238 and H 239 which bend is also distinctly visible on Tschoopp’s map. Now Tschoopp has probably worked with the old Cuban military map, which is very unreliable. I believe this the most plausible solution for the incongruity.

600 m after H 239 outcrops are still reported, then till H 240 nothing is
observed. Here, however, a conglomeratic limestone with Tuff Series pebbles is found. In the limestone-cement *Gümbelina* occur. Also quartz fragments have been observed, so obviously a Habana limestone. Then at H 241 the road crosses low ridges, consisting of Habana limestones with *Rudist* fragments. 100 m after H 241, we descend in the valley of the Rio Sevilla, where no outcrops have been observed till a depth of 5 m. On the azimuth on which H 242 is situated we ascend a hill on which Guines limestones and fossiliferous marls are sampled. MacGillavry assigned these rocks to the Eocene, which, in connection with the occurrence of Guines fossils as *Arcaia* and *Amphisorus* must be wrong. At H 243 they are again sampled. 800 m beyond H 243 we have ascended again into a plain. In the end we are in a village according to our informer called Carretera de San Francisco. According to MacGillavry it is called Esperanza. From this point the sugar-mill San Francisco is lying at about 1500 m to N 205 E.

This course is the only one where strikes and dips are sufficiently available so as to permit speculations concerning the tectonical relations. If we accept the simplest interpretation of the data, we get a Habana syncline at H 230 and an anticline between H 239 and H 240. In the core of the anticline the Tuff Series reappears. As to the relation between Tuff Series and Habana Series not enough data are available. The relation of Guines Series and Habana Series offers no difficulties. On our map Tschirpe’s strikes are sketched in as they are found on his map, but on the accompanying section I assumed them to be situated N of H 237, as discussed above.

*From halfway between Veinte y Uno and Sa. Lucia to the South. R 165—R 174.*

In the beginning real Tuff Series is found. At R 166 the first deviating rock is sampled, it is an amphibole porphyrite, with many vitreous amphiboles, generally with ore rims. Now the occurrence of amphibole as a phenocryst is rare indeed, but MacGillavry (p. 9, 10) has demonstrated the occurrence of amphibole porphyrites in the Tuff Series. Then at R 167 a conglomerate is sampled, which is quite comparable to those found at H 228, 229 and probably H 287. This conglomerate consists of pebbles of all kinds of Tuff Series volcanic rocks. Very striking is the nature of the cement. This consists of augites, small porphyrite fragments, ore grains, some opalised felspars, with opal and zeolite filling the intermediate spaces. Among the pebbles an amphibole porphyrite is found, proving the occurrence of amphibole as a phenocryst in Tuff Series rocks. Another striking phenomenon is the opalisation of some of the pebbles as well as of the cement, which accordingly dates from Habana or post-Habana time. At R 167b, c two augite porphyrites are sampled, thus we are again in Tuff Series. The conglomerate appears again at R 167a. Then at R 168 a loose augite-biotite porphyrite is sampled. It might be a constituent from a conglomerate. Proceeding, continuously conglomerates are reported, one of the pebbles, R 170, an augite porphyrite, also containing hypersthene and amphibole as phenocrysts. At R 170a, b amphibole-biotite-quartz-porphyrite tuffs are sampled. These typical Habana rocks at once strike
one as different from the Tuff Series rocks, as they are lighter coloured and lighter of weight. The last contains an inclusion of Tuff Series porphyrite. Proceeding, the conglomerates predominate. At R 171, R 171a and R 172 again Tuff Series augite-porphyrites have been sampled. Then at R 172a porphyrite-tuffs are sampled, which contain no quartz, but habitually looks like Habana-tuffs, so their position is uncertain. Then at R 172b biotite-amphibole-augite-quartz-porphyrites are sampled and at R 172c vitreous tuffs, with probable Radiolaria; of both outcrops strike and dip have been measured. Proceeding, again pebbles are reported, and 800 m after R 172c, a fragment of white limestone is reported, probably of tertiary age, but, as it has not been sampled, no conclusions are drawn. Immediately afterwards, coarse conglomerates are reported to alternate with fine ones, further on we enter flat sugar country with black soil. In our notes the question is raised, whether this is an off-shoot of the tertiary plain, which is found in the south, and also whether the conglomerates might constitute the tertiary basal conglomerate. As no samples have been taken of these conglomerates, the most plausible inference is to correlate them with the conglomerates hitherto found and as these alternate with the Habana tuffs, a Habana age is the most probable. It is quite well possible that the flat country is tertiary, but soft weatherable marls of Habana age have also been reported, and from these the same type of country might result. Just before the railway crossing conglomerates forming a small hill are reported, according to the notes: „probably Habana piercing through the Tertiary”. Then at R 173 and R 173a a stratified porphyrite-tuff and an augite porphyrite have been sampled, which have been assigned to the Tuff Series.

Immediately afterwards light-coloured arenaceous rocks are reported of which strike and dip have been measured, followed by conglomerates, and then again by light-coloured measurable tufts. From the end to the N and E on a stretch of about 3 km Habana-hills could be observed. To N 100 E, some 4 km away a depression is thought to occur of which the supposed tertiary, before the railway-crossing might form an off-shoot. This depression is probably the same as the one found at course H 285—H 286.

**North and South from station Berrocal. H 287—H 288; R 140, R 140a; H 283—H 286.**

From the beginning continuously porphyrites are observed, which are sampled at H 288, and appear to be augite-porphyrites. Then until H 287 nothing is reported. Here conglomerates are found, consisting of pebbles of volcanic origin; this sample has been lost, but is supposed to be similar to the Habana basal conglomerates as found at H 228, 229 and elsewhere. Accordingly the boundary Tuff Series—Habana Series has been drawn between H 288 and H 287. 1000 m before Berrocal again porphyrites and volcanic breccia’s are noted, the age of which remains obscure. From Berrocal to the south weathered

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1) See errata.
COURSES SURVEYED

Porphyrites are reported, which persist about 1100 m; then outcrops cease to occur. For paving the roads porphyrites and (?) tertiary limestones have been used. At R 140 a silicified tuff has been sampled. At R 140a a pebble taken from a white marl appeared to be an augite-porphyrite. This marl might be anything from Habana to Guines.

Proceeding from R 140, till H 283 tuffs and porphyrites have been reported in the fields. At H 283, 200 m to the right a low ridge occurs, which is crossed later on at H 285. Habana limestones have been sampled containing many specimens of Titano-sarcolites giganteus Whitfield. Till H 284 no outcrops; here a silicified porphyrite is found. Then at H 285 the Habana-ridge is crossed; again Rudists are found, which occur in large quantities. Till H 286 continuously Rudist-bearing limestones are found, and one limestone, sampled at H 285a, which contains no organic material but undulose quartz fragments: Habana Series[1]. At H 286 Guines limestones are found, containing Archaeus and Amphibisorus. As on this course samples are to scarce to allow speculation, most of the course, between H 287 and H 285 has been left blank.

From Jobabo to Berrocal, R 138, R 139.

At R 138 two samples have been taken of a porphyrite and a tuff, both not containing primary quartz. At R 138a a quartz-porphyrite tuff is found. Accordingly these rocks have been assigned to the Habana Series and Tuff Series resp. I want to emphasize however, that this dogmatic behaviour may be far from right, but due to a lack of data and samples a dogmatic point of view was inevitable, to have at least something of an order.

1600 m after R 138a the country becomes flat, no outcrops have been observed; this goes on till 1300 m before R 139. I have tentatively assigned this part to the Tertiary. Then porphyrites start to crop out which are sampled at R 139. This very fresh porphyrite has idiomorphic phenocrysts of pleochroitic hypersthene instead of augite. Hypersthene has also been found as a phenocryst at loc. R 135 and R 170. Till Berrocal continuously outcrops of porphyrites are reported. On this course again much has to be left blank, owing to a scarcity of samples.

The Carretera Central from Guaimaro to the East. R 85—R 98, H 158—H 154, T 947—T 964, T 1009.

This course has also been surveyed by Tschoff. As he used the Cuban Military map which often differs considerably from ours, his localities could not be located exactly.

250 m before R 85 we have left the diorite sands and at loc. R 85 an uralitised augite porphyrite from the Tuff Series is sampled which showed a questionable stratification. At R 85a loose blocks of amphibole-quartz-diorite porphyrites are sampled, probably originating from a dioritic dyke. Continuously outcrops of porphyritic rocks are observed. At R 85b a uralitised

1) See errata.
porphyrite-breccia is sampled; uralitisation has ceased at R 85c, here an albiteised porphyrite-breccia is sampled. Proceeding, again loose blocks of a quartz-diorite-porphyrite R 85d are lying around. Then at R 85e a marble is found, followed at R 85f by an augite porphyrite-breccia, which has been measured. Then till R 86 only porphyrites are sampled, of which R 86a may be mentioned as it is an augite porphyrite-tuffite with Radiolaria. This rock consists of angular fragments of a very dense material, partly calcitised and chloritised, with augite phenocrysts and remnants of organic material. These fragments are cemented by calcite and chlorite, often bordered by dirty ore streaks, which also penetrate into the original material, forming skeletons. In the cement circular and brain-formed concentrations occur, which consist of irregularly bordered felspar, not twinned and with a higher refractive index than the balsam. It also occurs in veins, together with calcite and it has penetrated into the tuff-fragments. The origin of these peculiar forms remains obscure (pl. I, fig. 1). R 88a is a mylonitised porphyrite. Then at R 89 and R 89a resp. green and black tuffites are found, both with Radiolaria; in the latter rock dykes of quartz-diorite porphyrite occur; though no traces of metamorphism are found, these rocks have been assigned to the Tuff Series. At R 90 a regular Tuff Series porphyrite has been sampled; then at R 90a-g in a quarry, which has been sketched in on the map, we have the following rocks: a-silicified and epidotised porphyrite, b-biotite-diorite porphyrite, c-quartz-diorite porphyrite, d-quartz-diorite porphyrite, e-calcitised porphyrite. On the right side of the road a spilitic occurs and immediately afterwards another spilitic is sampled. The most striking fact observed here is the total lack of metamorphism in the Tuff Series rocks. The only possible explanation is that the dioritic dyke is too far from its base to render metamorphism possible. At R 90h, R 90i−j and R 90 m Tuff Series rocks have been sampled. The only mentionable rocks are R 90k, a marble dyke in a totally mineralised rock consisting of chlorite, quartz and white mica, and R 90m, an organogeneous Provincial Limestone with an inclusion of a porphyrite. These rocks are comparable with R 86b, which is a breccia of porphyrite tuff in a calcite cement. These are all supposed to be products of the slickenside of porphyritic rocks and Provincial Limestones; R 90i is lost.

Then beginning at R 90n to R 91 all samples are tuffites, more or less calcitised. With the exception of R 90p none of them contain quartz, but nearly all of them contain Radiolaria. These rocks have been assigned to the Habana Series as such a predominance of light tuffs is never encountered in the Tuff Series.

Among the rocks which were sampled by Tschoopp on this stretch, at T 947—949 three contained primary quartz.

At R 91 marls have been sampled, which are lost and Habana-limestones with Rudist fragments. Tschoopp, at about this point (T 950) sampled a tuffite with sponge needles and probable Gümbojina. Till R 92 only tuff and tuffites are found, some of them containing quartz; Tschoopp’s samples T 951 contained Gümbojina in one case. Then on a stretch from 400 m before R 92 till about
200 m after it, coinciding with T 952 and part of the samples of T 953, only porphyrites are found, containing no quartz. This stretch has tentatively been assigned to the Tuff Series. At R 92a a radiolarian tuffite is sampled. Tschoop sampled a lot on this stretch at the locs. T 953—T 957. All rocks were tuffites or radiolarian tuffites, some with quartz, with the exception of two samples T 955 amphibole porphyrite breccias cemented by calcite. This might be a Tuff Series outcrop, but it is very uncertain, as the samples are very much weathered and very difficult to determine, so they have not been indicated on the map. In his samples Tschoop distinguished T 957a and T 957b, a distinction which has not been made on his map. T 957a is a Habana quartz porphyrite, but T 957b is a metamorphosed Provincial Limestone, containing small garnets, which is partly recrystallised. This is apparent as in many places the remnants of organic material have disappeared. Accordingly the boundary Tuff Series—Habana Series has been drawn. At the locs. R 93—93g alternately uralitised augite-porphyrite and limestones with more or less garnet and epidote are found. 1300 m after R 93 the soil becomes sandy, which at 1900 m after R 93 appears to be the typical sandy diorite soil. These sands persist till R 96. At R 94, 95 and 95b dioritic rocks are sampled. At R 96 two uralitised augite-porphyrites occur, immediately followed by diorite sands. At R 97 a uralitised tuff again points to Tuff Series. Then continuously metamorphosed Tuff Series rocks are found: uralitisation and in two cases at R 97 and at T 959 biotitised rocks occur: a spilite and a tuff. Immediately after R 97f diorites occur again. At R 98 an epidotised, chloritised and silicified porphyrite is found, corresponding with T 962; the same rock. They have been provisionally assigned to the Tuff Series. R 98a is lost, but at R 98b a limestone with tuffogenous material and Radiolaria is found, obviously belonging to the Habana Series; this rock corresponds with T 964. T 965 is also lost. Then till H 158 a couple of hills are passed, reported to consist of marls, which have not been sampled. Also tuffs are reported, but at these rocks are often used to pave the highway, their origin is uncertain. At H 158 a quartz-porphyrite tuffite is found lying alongside the road. Sample T 1009 is lost but on his map Tschoop mentions Miocene with Ostrea and Pecten and sketched a small strip of Miocene crossing the Carretera. Then till H 157 occasionally tuffs or limestones are reported. At H 157 limestones containing quartz and Gümnelinas occur. Then till the end only marls and limestones are exposed, belonging to the Guinea Series, both sterile, but about the limestone of H 155 there can be no doubt as to its age.

From the Carretera Central, about 7 km E of Guaimaro, to the North.
R 135, R 136.

At R 135 an augite-porphyrite, at R 135a a silicified, amygdaloidal spilite; convincingly Tuff Series. Here again no signs of metamorphism are observed. Big blocks of diorites are seen to crop out at R 136.

Going back Van Raadsheuven followed a road, indicated by the dotted line to the ESE, without taking any measures. Approaching the Carretera
From the Carretera Central, about 10 km E of Guaimaro, to the North. K 109—K 112.
Beginning with Tuff Series, at K 109 an epidotised porphyrite is sampled. KINGMA has been heading for a hill, loc. K 110, where large blocks of porphyric biotite-amphibole-quartz-diorites were found. Slightly back, at K 111, K 111a, b and K 112 uralitised porphyrites have been sampled.

From 10 km E of Guaimaro to the North. K 139, K 140.
At K 139 we are at the border of the hilly Tuff landscape and come into the softly undulating diorite landscape. Here an odinite has been sampled. Till the end diorite sands. At about 5 km N of the cross-road, still diorite is found. Further to the N only diorite sands are found. It must be noted, that though held to belong to the diorite formation, it is not impossible that the sands were in younger times transported to the North and thus may constitute a younger i.e. tertiary formation.

From the W to San Agustin and then to the N. F 246—F 248.
On this course till F 248 only dioritic rocks are found. At F 248 a Habana limestone is sampled, containing Pseudorbitoides.

From point A (halfway San Agustin and Carretera Central) to San Agustin (V 145—149), and from point A back to the Carretera Central (V 150). V 145—150.
In the beginning the soil consists of diorite sands. At loc. V 145 a single uralitised augite porphyrite is found amidst these sands. This might be an inclusion in the batholite. At V 146 again an augite-porphyrite is found, amidst diorite sands, but only very slightly uralitised; only a couple of augite phenocrysts have been slightly changed into fibrous uralite; the slight degree of metamorphism is striking. Then till San Agustin only diorites are found. From point A to the south the soil remains diortite (many times dioritic outcrops could be observed) till loc. V 150a. At loc. V 150 again a silicified and augitised porphyrite has been sampled amidst the diorite sands, this rock shows a more satisfactory degree of metamorphism. At V 150a several augitised porphyrites have been sampled, and also an augite-bearing odinite. They are situated on a ridge of small hills, striking about N 120 E. Diorites start again at loc. V 150b. Till loc. V 150c diorites keep on cropping out. Here thick horizontal layers of conglomerates occur, the samples of which, alas, were lost. Then again diorite sands occur, but at V 150d the conglomerates are found again, containing many pebbles of tuffs, which might as well belong to the Tuff Series as to the Habana Series. Till V 150c these conglomerates alternate with the diorites. As the exposures were too small to indicate on the map, two larger outcrops have been drawn. At V 150e a tuff is sampled which might belong to the Tuff Series, as it contains no quartz, but on the
other hand it shows no traces of metamorphism. It has been provisionally
assigned to the Tuff Series. Here some strikes and dips are measured.

The age of these conglomerates remains uncertain. According to their
horizontal position they might be anything from Eocene till younger. They
have been provisionally assigned to the Eocene, as similar eocene conglomer-
ates are known from this area, whereas younger conglomerates have not been
found here.

From the Carretera Central halfway between Guaimaro and Victoria de las
Tunas to the North. R 106.

In the beginning no samples were taken, only tuffs are mentioned. At
R 106 diorite sands begin.

From the Carretera Central to the S, to Jobabo. L 1—8.

The first two samples, taken at loc. L 1 and L 1e apparently belong to
the Habana Series: a grey, fine-grained tuffite with some felspar- and quartzsplin-
ters and a single augite, and a limestone with volcanic material, among which
some quartzsplinters. At the side of the quartz, the stratification of the tuffs
goes as an argument for Habana age. Sample L 1b is lacking. L 1e is a quartz-
limonite rock, comparable to rocks as found on course H 136—150, and thus
should be classified with the Tuff Series. At loc. L 1d again a tuff is found,
quite comparable with the Habana tuffs: grey, fine-grained, but as it contains
no quartz the age is uncertain. This case presents one of the difficulties which
arise so often: either the mineralised rocks are found in both Tuff- and Habana
Series, or light-coloured finegrained tuffs occur in both series. For the present
the tuff of L 1d has been assigned to the Tuff Series.1) Proceeding, abundant
rock fragments were found in the ploughed fields. Sample L 2 has been lost.
At loc. L 3 we find a normal Tuff Series augite-porphyrte, which rocks persist
until at loc. L 6a, b Provincial Limestones are met with. L 7 again is a quartz-
limonite rock. At loc. L 8 difficulties arise again. Here we find an amphibole-
augite-porphyrte. Now amphibole generally does not occur as phenocrysts in
Tuff Series porphyrtes. MacGillivray (p. 9, 10), however, as mentioned
before, proves the occurrence not only of amphibole but also of biotite as
phenocrysts in the Tuff Series. The position of L 8 also produces no decision
as to age of this sample. It might be connected with the Habana-outcrop to
the Sw, on course R 138—140.

From Jobabo to the NE, to the Carretera Central. F 210—F 218, K 115—
K 132.

Beginning SW of sugar-factory Jobabo. The country is absolutely flat;
black-grey soil with limestone-fragments. Very probably Tertiary. At loc. F 210
the soil has been sampled. It appeared to be light brown grey clay with numerous
small tuff and porphyrte fragments. As the country is still flat a tertiary age

1) See errata.
is the most probably. At F 211 the country becomes hilly. Here and at F 212 epidotised and chloritised porphyrite-breccias have been found, which are held to be Tuff Series rocks. At F 213 we have a brown-yellow fine-grained porphyrite without quartz, which offers the same problem as at loc. L 1d. The position between Tuff Series rocks (together with it a chloritised porphyrite has been sampled, which undoubtedly belongs to the Tuff Series) and the absence of quartz indicates a Tuff Series age, whereas the habit of the rock points to a Habana age. F 214, 215 and F 216 are again Tuff Series porphyrites. But at F 217 a sterile white marl has been found with small porphyrite pebbles. This marl might be intercalated, but it is equally possible that it presents a remnant of the former tertiary cover. F 218 is a very peculiar, very dark green-grey granular rock, microscopically consisting of andesine-labrador and augite with interstitial quartz. Concentrations of chlorite and titanite occur, in which little streaks of unchanged amphibole have been found. Magnetite is accessory. Secondary calcite is found. In the felspars small cloudy patches of albite occur. The holocrystalline texture tends to become porphyritic, but a gradual transition from the larger to the smaller felspars is found. The position of this rock remains unknown. It might be a coarse-grained diabasic rock belonging to the Tuff Series, but for the quartz. In the Habana Series such rocks are unknown, and a diorite origin is, although not impossible, far from probable in connection with the large distance to other diorite outcrops. Up to K 132 no problems have arisen. All samples obviously belong to the Tuff Series. Again some quartz-limonite, and in one case, K 124, quartz-epidote rocks are found. K 120 furnished a diabase porphyrite, rather similar to F 218, but definitely porphyritic and containing no quartz. K 131 and K 132 are silicified spilites. At K 132 also a radiolarian tuffite is found, containing quartz, obviously belonging to the Habana Series. These rocks persist till the end of the course!

From the South to the Carretera Central at Collegio Adventista. F 183—F 187.

Directly in the beginning Tuff Series porphyrites are found: F 183a, b, c, d. At F 184 a sterile grey-white marl is found, containing limestone concretions and porphyrite and tuff fragments; probably Tertiary. Turning northward again Tuff Series is found: at loc. F 185a. F 185b furnished a silicified diabase and radiolarian tuffites, the latter green-coloured, quite comparable to the equally green Tuff Series tuffites from loc. H 223. At F 186 amygdaloidal spilites have been found. Then at loc. F 187 a limestone with Rudist fragments: Habana Series, followed at F 187a by an amphibole-quartz-porphyrite, which, in connection with the primary quartz, has also been assigned to the Habana Series. Till the Carretera Central no more samples have been taken. The soil is black and sometimes brown, but towards the Carretera becomes much lighter coloured. Near the end in ant-hills white marls are exposed.

From the Carretera Central between Guaimaro and Victoria to the South. W 181.

The whole course lies on diorite land.
From the Carretera Central about 10 km W of Victoria to the South.

V 190—V 194.

Starting in diorites, at V 191 metamorphosed Tuff Series rocks are found: augitised porphyrites, further on, at V 191a a conglomeratic limestone has been sampled. In a calcitic cement we find large porphyritic inclusions with partially rounded-off edges, but besides, mineral fragments with irregular edges occur, which might as well have been blown-in as sedimented-in. So the position of this rock remains uncertain. The most plausible solution would be that we have to do with a remnant of a tertiary conglomerate, but rocks of this kind are not known in this area. Till the end only metamorphosed rocks occur, obviously belonging to the Tuff Series. To the S the hilly country continues over at least 2 km. Here the country is hilly in contradistinction to the flat or gently undulating diorite country.

A hill W of Victoria de las Tunas. R 137.

At the course along the Carretera Central at R 96 metamorphosed porphyrites were found on a hill at the S. side of the road. This course has been surveyed to find out how far these hill extended to the south. In the beginning again a sample of the „porphyrites” was taken, which proved to be an augite-plagioclase-garnet rock. 260 yards from the beginning at R 137a a biotite quartz-diorite is found. Till the end the diorite persists. Consequently the hill forms an isolated outcrop of porphyrites from the Tuff Series.

From Victoria de las Tunas to the North. K 92—K 102.

In the first part only dioritic rocks are met with. Among these, sample K 92a is worth mentioning. It consists for the larger part of large, hypidiomorphic labrador, some, large, locally partly uralitised augites, a single grain of quartz, some titanite, veins and crystals of epidote, some magnetite. The predominating labrador marks this rock as a labradorite. The boundary Diorite-Guines could be easily established. Till loc. K 98 only Guines marls and limestones are reported. But K 98 and K 99 furnished mineralised rocks as found in the Tuff Series: silicified rocks with chlorite, at K 99 also with sericite, K 98 still showing its porphyritic origin. Directly after K 99 again Guines marls are found, persisting till the end. In Dumañuecos the streets have been paved with silicified rocks as found at K 98 and 99. The same rocks have been sampled at K 101 where one of them contains alunite. They probably originate from a hill about 600 m to the SE from Dumañuecos. Similar rocks have been found by v. Wessem (p. 11).

From Victoria de las Tunas to Vásquez, northern route.

V 166—V 170, W 202—W 209.

Stratigraphy on this course presents no problems. The boundary Diorite-Guines is established in the same way as on course F 197—204. The only rock which claims our attention is sample V 168. It has a porphyritic texture. Very big basic plagioclases and amphiboles occur in a groundmass of smaller
plagioclase laths and amphiboles. The groundmass is very coarse and tends to ophitic texture. The problem this rock presents lies in the fact that the amphibole is uralitic and with the exception of some phenocrysts is totally allotriomorphic, thus presenting the complete pattern of a metamorphic diabase. But as autometamorphism of dioritic rocks might cause the same features, this rock has preliminarily been assigned to the diorites.

From Victoria de las Tunas to Vasquez, southern route. F 197—F 204.

On this course no difficulties arise. The boundary between diorite and Guines Series could be established easily by the disappearance of the diorite sands and the appearance of limestone fragments in the soil. Only sample F 203 is worth mentioning. It consists of rhomboid crystals, pointing to dolomite.

From the Carretera E of Victoria de las Tunas to the NE to establish the northern boundary of the Tuff Series. W 192—W 193. (map B)

At W 192 two spilites have been sampled, and at W 193 a porphyritic rock. Directly after W 193 diorites are found to crop out. Striking is the fact that these Tuff Series rocks do not show any trace of metamorphism, however close to the diorite contact. Only the plagioclase of W 193 had a cloudy habit which showed much resemblance to the plagioclases of the veins in the samples of W 194.

From the Carretera E of Victoria de las Tunas to the South, W 194. (map B)

From the same point on the Carretera to the South. This course remains in the Tuff Series. At the end four samples have been taken of uralitised diabases with veins of garnet-epidote-plagioclase-quartz.

From 5½ km E of Victoria de las Tunas to the N to establish the diorite boundary. K 113—K 114.

150 m before K 113 the sandy diorite soil makes way for a darker-coloured soil containing tuff-fragments. At K 113 and K 114 augite-porphyrites are sampled, of which only the first is slightly uralitised.1) The rocks at K 114, however close to the contact, are not metamorphosed, which goes to prove that it is not always necessary to assume an Habana age for rocks which, though lying close to the diorites, are not metamorphosed.

From the Carretera Central, about 9 km E of Victoria de las Tunas to the N and then to the W. R 121.

On this course continuously diorite sands occur, but at R 121 two spilites

1) See errata.
have been sampled, in the groundmass of which very much biotite occurs, which must be considered as products of metamorphism.

*From the railroad-crossing of the Carretera Central E of Victoria de las Tunas to the NW (along the railroad). V 171, V 172.*

The first 400 m diorite fragments are found, then, in the country rocks begin to occur, four of which are sampled V 171: two uralitised porphyrites, one augite porphyrite and a granophyric granite-aplite. About 1000 m after V 171 diorite sands start to occur again. At V 171a an epiderised tuff is sampled, probably striking N 55 E: Tuff Series. Till V 172 the country is typical for Tuff Series: undulating, with small hills consisting of more resisting rocks. At V 172 in a quarry a silicified tuff is sampled. If found amidst Habana rocks, this sample would undoubtedly have been assigned to the Habana Series, but as no primary quartz occurs we provisionally assign it to the Tuff Series. Two times a strike could be measured. V 172a, b are both mineralised rocks, as often found in the Tuff Series. 100 m after V 172b we are in the diorite again. The problem again is: why are these rocks not metamorphosed? The solution, that these rocks are not metamorphosed because they belong to the Habana Series, cannot be contemplated now, as it would involve too many complications; moreover, at other places, e.g. K 114, regular Tuff Series rocks close to the contact are neither metamorphosed.

*From 9 1/2 km E of Victoria de las Tunas to the North. R 126—R 129.*

At the beginning diorite sands. At R 126 in a quarry tuffs and porphyrites crop out, striking N 95 E, dipping 70—80 N. Three samples have been taken: an amphibole diabase, a tuff-breccia and a silicified tuff. One would be inclined to assign these rocks to the Tuff Series, but in that case why are they not metamorphosed? At least there are no obvious signs of metamorphism. What may be taken as an indication of it, is the habit of the amphiboles in the diabase. These amphiboles are very obscure, (the rock was strongly weathered and no satisfactory sections could be made) but at some places they appear fibrous and this may represent uralite. Besides, in the silicified rock small biotite flakes occur in the groundmass, an unusual feature, but it is also found at loc. R 121 (two samples) in spilites, close to the diorite contact. On the other hand the tuff-breccia does not bear the least indication of metamorphism. Till R 127 continuously tuffs are reported. At R 127 and R 128 dioritic rocks are found, the soil between, however, is not sandy. Then at R 128a, b, c, again porphyrites are sampled, the first two again bearing no trace of metamorphism, the last on the contrary is uralitised. ¹) This would lead to the conclusion that the diorite „tongue” at R 127, 128 presents only a small offshoot of the main body and that at R 128c, we are very close to the large batholith found in the North. 80 m after the beginning of the last azimuth of this course, the porphyrites cease to occur in the fields and ant-heaps reveal marls. At R 129 an *Archaean*-bearing limestone is sampled, indicating Guines Series.

¹) See cerata.
From 10 km E of Victoria de las Tunas to the North. R 122—R 125.

At R 122 a porphyrite-breccia is sampled, consisting of all kinds of porphyritic fragments in a dense, nearly isotropic groundmass. No quartz is found. The position of this rock is uncertain, but as similar rocks are not known in the Habana Series, and as they occur everywhere in the Tuff Series, it has tentatively been assigned to the Tuff Series. Then at R 122a Habanatuffs are found, followed at R 122b by another questionable epidotised porphyrite which for the same reasons as before has been assigned to the Tuff Series. It must be noted that the relative extension of the Tuff Series and Habana Series is unknown, as with the exception of the stretch between R 122a and R 122b, where similar rocks as the tuffs of R 122a are reported, no outcrops have been reported between the localities. At R 123, two limestones have been sampled, with numerous felspar and some quartz fragments, one of the samples contains some indistinguishable remnants of smaller foraminifera: Habana-formation; at R 123a, b tuffs are found in the fields, one of which contains quartz. Along the railway again limestones with quartz fragments are found, lying all over the fields. At R 124a a sterile marl has been sampled, the position of which, as it appeared to be sterile, remains uncertain. Then, at R 124b again, quartz-containing limestones have been found. R 125 furnished a totally weathered rock which could not be sectioned. At R 125a the Guines formation appears: white marls with abundant smaller Foraminifera and undeterminable Lamellibranchiata, followed at R 125b by coral-bearing limestones.

The most eastern course, reaching the Carretera Central from the North. W 182—W 191.

On this course only Guines limestones and marls were sampled, containing ample paleontological evidence as to the age of the rocks.

To the extreme SEi from the Carretera Central. K 89—K 91.

On this course only soils are sampled, which, with exception of K 91 where some specimens of Rotula beccari L were found, proved to be sterile. It is possible that not only Guines, but also younger formations are involved, especially in the south.

From the Carretera Central about 9 km E of Victoria de las Tunas to the South. H 184—H 194.

In the beginning diorite sands occur which persist till the river-crossing. 100 m further on uralitised porphyrite-breccia’s are found, followed by a plagioclase-augite-garnet-quartz rock at H 185, obviously Tuff Series. Then in the river valley at H 186 amphibole-diorites are sampled, which persist till H 191. Here again uralitised porphyrites are found. Till the boundary of Tuff Series and the Guines continuously metamorphosed porphyrites are found. At this stretch the country is hilly. Then the country becomes absolutely flat, and at H 194a marl is found. In this case the boundary is manifest through
the change of country. This same boundary is found when turning back to
the W. At once porphyrites are found again. At H 194 strongly metamorphosed
Provincial Limestones are sampled. They contain idiomorphic, anomalous,
zoned garnets and micaeous haematite.

From the Carretera Central 3 km E of Victoria de las Tunas to the South.
R 107—R 120. T 1087—T 1089.

We start in the Tuff Series, which until the diorite-contact appears to be
metamorphosed: R 107a-d. At R 108 a weathered quartz diorite is sampled,
450 m past this point R 108a is sampled. This proved to be an albite-uralite-
auquite rock, containing amphibole phenocrysts with augite cores: ex-augite
porphyrite. The albite has not the cloudy habit of the albite in albitised
porphyrites, but is perfectly clear. It occurs amidst diorite sands. This occurrence
suggests that in this case we have to do with an inclusion of Tuff Series in
the diorites. At R 109 a granio-diorite aplite is sampled. Then at R 110, a
uralitised and chloritised porphyritic mouldrock is found, probably a Tuff Series
inclusion, as it again occurs amidst diorite sands. Also at R 112a a meta-
morphosed Tuff Series rock is found: a quartz-garnet rock with plagioclase
and epidote. From R 111 until R 112a a continuously strongly metamorphosed
Tuff Series rocks are found alternating with aplites. In one case, R 112b,
dioritic rocks are covered by uralite-tremolite-plagioclase rocks. At R 112b
the diorites start again. On this stretch pleonast-bearing rocks occur: R 111a.
After R 112b again diorite sands are found, with one interruption at
R 112f, where a uralite-plagioclase rock proves the existence of Tuff Series.
At R 113 the diorite sands cease to occur and here an oidine is sampled.
Tuff Series is found again at loc. R 114 and R 115, where uralitised porphyrites
are met with. Till Las Arenas dark rocks are reported to crop out continuously.
In Las Arenas close to a small valley an augite-porphyrite (R 116) and probably
nearly vertical, silicified rocks R 116a with epidote and alunite are found.
These last rocks can be compared with the mineralised rocks as found elsewhere,
and thus are believed to belong to the Tuff Series.

We had three samples from Tschope (T 1087, 1088) from a place about
750 m E of the cross-roads, N of Las Arenas: a Habana-limestone with Radists
and Pseudosteolites and two breccias, consisting of porphyrite fragments with
sharp edges in a calcite groundmass. They were found on a ridge striking
about NW—SE. This ridge agrees with one measured which dipped 26° to
the south. Proceeding on our course we find at loc. 116b and c Guines lime-
stones, dipping 20° to the south. Further-on weathered porphyrites are observed.
Then, at T 116d, e, f we find a grey marl of indefinitely age, a marble and a
calcitised and chloritised porphyrite breccia, obviously from the Tuff Series.
At R 117a beside an amygdaloidal augite porphyrite, Guines limestones are
found. Till R 118a continuously limestones and marls are reported (sample
R 118), but here a spilit is sampled. Also at R 118b Tuff Series rocks are
sampled: porphyrite breccia. Then, with the exception of loc. R 118a, where
again a porphyrite breccia is sampled, till the end of the course only Guines
marls are sampled. Close by R 119 Tschopp has sampled a Guines limestone, with the typical cavernous habit. We may not exclude the possibility that also younger rocks occur as especially to the south they could be expected. But as no fossils were found, they could not be proved to be present.

On the area between the samples no exposures are observed.

*From Victoria de las Tunas to the South.* W 195—W 200.

No samples were taken before the boundary Diorite-Tuff Series had been attained at W 195, where a uraltised porphyrite and a calcite-garnet-quartz rock has been found. At W 196 two marbles have been sampled, followed at W 197 by a fluidal spilitic, all unmistakable Tuff Series rocks. Then at W 198 a limestone with *Rudist* remnants is found. Till W 199 a lot of tuff exposures are observed with veins of white material resembling marls, but no samples have been taken. At W 199 a marl is sampled which proved to be sterile. Till W 200 no exposures are reported. Here we find again one of those silicified and limonitised porphyrites: Tuff Series. About 400 m further-on flat country and a sandy soil is reported on which the boundary of the Tertiary is based. 100 m before the cross-roads yellow limestones are reported, which are sampled on the cross-roads. This appeared to be an eocene limestone with vertical sections of *Discoclyina* and *Pellatispirella*.

*From Victoria de las Tunas to the South.* W 244—W 264.

After the diores of Victoria de las Tunas, about 400 m past the cross-roads the boundary Diorite-Tuff Series could be established. Accordingly, at loc. W 244 and 245, 246 metamorphosed rocks are found. As the distance to the contact is rather great, metamorphism is not very intense: uraltisation, and recrystallisation of limestones to marbles. Then at W 247 we have typical Habana rocks: *Günbelina*-bearing limestone with rounded-off quartz grains. At W 248 mostly limestones are found, containing *Rudist* fragments and sections of *Pseudorbitoides*. At W 248 we have a calcitised and zeolitised rock with some felspar and groundmass remnants; the supply of tufoaceous material must have been increased here. Then up to W 253 limestones with Habana-fossils and a single quartz-porphyrite tuff are found, presenting no difficulties. At W 253 a porphyrite is sampled, a rock most obviously belonging to the Tuff Series. At W 254 again a Habana limestone with *Rudist* remnants is found lying upon strongly weathered porphyrites, followed at W 255 by a quartz-limonite rock. W 256 again furnishes a Habana-limestone with *Günbelina*. Then a conglomerate is found with porphyrite boulders, and at loc. W 257 red porphyrites occur, followed again, at loc. W 258, by porphyrite-conglomerates. At W 259 an amygdaloidal augite-porphyrite is sampled; Tuff Series. W 257 and 259 obviously belong to the Tuff Series.

The conglomerates probably present the basal conglomerate of the Habana Series. At W 260 a tuffite is found without quartz or determinable fossils, habitually belonging to the Habana Series. W 261 is of uncertain origin: a porphyrite with inclusions of older porphyritic material; clear labradors in
a glassy groundmass, no quartz; provisionally Habana Series. After W 261 the country becomes flat and sandy: tertiary country. Just before W 262 porphyrite conglomerates crop out again. At W 262 and W 263 a soil and marl were sampled, which contained no fossils. W 263a, however, furnished a typical Guínes limestone. 400 m afterwards the porphyrite conglomerate is observed again. At W 264 an amphibole-quartz-porphyrite is found and further on again conglomerates, so we are once more in the Habana Series.

LITERATURE GENERAL

Only those works, referred to in the text are compiled here. For extensive lists of West Indian literature I refer to:

L. M. R. Rutten: Bibliography of West Indian Geology. Geogr. Geol. Meded., no. 16, Utrecht, 1938, and to the literature lists found in the works on Cuban Geology which are mentioned below.

ERRATA

While constructing the map, the following mistakes were made:

1. The boundary between the Tuff Series of R 171 (S of Sa. Lucia) and the Habana Series to the S, has erroneously been drawn N of R 172 instead of S of it. Compare pag. 49.

2. S of Berrocal the stretch from the ridge of H 285 to the boundary with the Tertiary has erroneously been left blank. It should have been coloured brown. Compare pag. 50.

3. The boundary of Tuff Series and Habana Series N of Colonia Yolanda should have been drawn slightly N of L 1c instead of S of it. Compare pag. 54.

4. In the Tuff Series at R 128c and at K 113, E of Resignacion, the dots, indicating contact-metamorphism have erroneously been omitted on the map. Compare pag. 58.