Literatur

Franzius-Institut für Wasserbau und Küsteningenieurwesen der Technischen Universität Hannover (Prof. Dr. Ing. Dr. phys. PARTENSCKY): 6 Teilberichte über die Modellversuche für das Neuwerker Watt. Hannover 1970/74.

GÖHREN, H. (1968): Triftströmungen im Wattenmeer. – Mitt. Franzius-Inst. Hannover, H. 30.

– (1969): Die Strömungsverhältnisse im Elbmündungsgebiet. – Hamb. Küstenforsch., H. 6.

– (1971): Untersuchungen über die Sandbewegung im Elbmündungsgebiet. – Hamb. Küstenforsch., H. 19.

– (1973): Hydrodynamische und küstenmorphologische Probleme bei der Planung des Tiefwasserhafens Neuwerk/Scharhörn. – Jahrb. Hafenbautechn. Ges. 33: 3–27.

– (1975): Die Sedimente im küstennahen Watt zwischen Elbe und Weser. – Hamb. Küstenforsch., H. 33.

HANSEN, W. (1973): Der Einfluß des geplanten Tiefwasserhafens Neuwerk/Scharhörn auf Wasserstände und Stromgeschwindigkeiten in der inneren Deutschen Bucht. – Hamb. Küstenforsch., H. 26.

HENSEN, W. (1939/40): Die Entwicklung der Fahrwasserverhältnisse in der Außenelbe. – Jahrb. Hafenbautechn. Ges., Bd. 18, Berlin.

KLUG, H. (1974): Morphologische Untersuchungen über den Einfluß des Kugelbake-Leitdammes und seiner geplanten Verlängerung auf die Watt- und Strandgebiete vor Cuxhaven. – Schr. Naturw. Ver. Schlesw.-Holst., 44: 97–106.

LAUCHT, H. (1973): Berücksichtigung von Fragen der Umweltbeeinflussung bei der Planung des Tiefwasserhafens Neuwerk/Scharhörn. – Freie und Hansestadt Hamburg, Behörde für Wirtschaft und Verkehr – Strom und Hafenbau.

LUCK, G. (1970): Stellungnahme zur Stranderhaltung durch künstliche Sandzufuhr im Raume Döse, Duhnen und Sahlenburg. – Forschungsstelle Norderney, Jahresber. 1968, 20: 35–45.

PARTENSCKY, H.-W. und RENGER, E. (1974): Modelluntersuchungen für den geplanten Tiefwasserhafen Neuwerk/Scharhörn. – Schiff und Hafen 26, 5: 447–455.

PARTENSCKY, H.-W. (1970/74): s. unter: Franzius-Institut.

SIEFERT, W. (1972): Windmessungen auf Scharhörn 1966 bis 1970. – Hamb. Küstenforsch., H. 24.

WOHLENBERG, W. (1953): Sinkstoff, Sediment und Anwachs am Hindenburgdamm. – Die Küste, 2: 33–84.

EVIDENCE OF FORMER GLACIATION IN THE SIERRA DE PERIJA, WESTERN VENEZUELA

With 1 Figure

CARLOS SCHUBERT

Zusammenfassung: Die wichtigsten Zeugen einer früheren Vergletscherung der höchsten Berge der Sierra de Perijá (Cerro Pintado) sind Kare, schroffe Felsgrate, Felsstufen und rundhöckerähnliche Strukturen. Diese sind in einer Höhe von über 2700 m zu finden. Darunter finden sich einige kleine, niedrige Moränen und Solifluktionsflächen. Die spätglaziale Schneegrenze lag in einer Höhe von ungefähr 3000 m.

The Sierra de Perijá is a remote mountain range located between 9° 0′ and 11° 10′ N latitude, 72° 10′ and 72° 30′ W longitude. Its divide is the border between Venezuela and Colombia. The southern half of the Sierra is named Serranía de los Motilones and reaches a height of 3750 m (Pico Tetarí) above sea level; the northern half is called Serranía de Valledupar, with elevations of up to 3600 m (Cerro Pintado) (SIEVERS 1888; *Sociedad de Ciencias Naturales La Salle* 1953; HITCHCOCK 1954; VILA 1960). These elevations are all below the present-day lower glacier limit in northern South America, which is at approximately 4700 m (SCHUBERT 1972). The geology of the Sierra de Perijá is still poorly known; the published reports are concerned mainly with the eastern foothills and the western Lake Maracaibo Basin (SUTTON 1946; HEA & WHITMAN 1960; MILLER 1960; BOWEN 1972). Recently, regional mapping was begun by the *Ministerio de Minas e Hidrocarburos of Venezuela* (ESPEJO 1973). However, the higher parts of the Sierra are of difficult access and most of the information on those regions must be derived from the study of aerial photographs.

The author is not aware of any previous report of glacial features in the Sierra de Perijá. The only indirect references to a high altitude tropical alpine *(páramo)* zone in the Sierra are those by SIEVERS (1888) and HITCHCOCK (1954). Although he did not reach it, SIEVERS refers to a páramo type vegetation on Cerro Pintado, from which he inferred a minimum elevation of 2800 m to 3000 m. The recently prepared topographic bases (Maps No. 5647–III–NE, –NO, –SE, and –SO) of *Cartografía Nacional* (Caracas) show elevations of up to 3600 m in the Cerro Pintado area (10° 30′ N, 72° 50′ W). The contemporary tree line is at approximately 2800 m elevation; above this is the páramo zone with a tropical high mountain climate. In the higher parts there is frequent nightly freezing and daily thawing, with the consequent solifluction and periglacial morphology. No climatic data have been systematically recorded in the Sierra de Perijá. Along the foothills, annual rainfall varies from 613 mm near the northern end of the Sierra, to 1452 mm in the central foothills, to 4523 mm near the southern end (WALTER & MEDINA 1971).

A study of aerial photographs of this area revealed some typical features of glacial erosion and sculpture, such as cirques, arêtes, rock steps, and features resembling roche moutonnées and whaleback forms. Fig. 1 is a glacial map of the Cerro Pintado area, showing the distribution of these features. The underlying rock is dominantly limestone of the Middle Cretaceous Cogollo Group (A. Espejo, personal communication, 1975). In the area north of Cerro Pintado, there is a high (3200 m) table mountain formed by the same limestone dipping slightly to the west, with a curious combination of solution karst structures, such as dolines and ribbed limestone pavements (lapiaz or karren), superimposed on glacial erosion features. Fig. 1 shows many dolines on top of this table mountain (informally called „Cerro Viruela", or „Smallpox Mountain", by speleologists).

In addition to glacial erosion features, there are evidences of small, elongate morainic ridges and solifluction mantles, especially on the northern flank of Cerro Pintado (Fig. 1).

The lowest cirque-like features were observed at

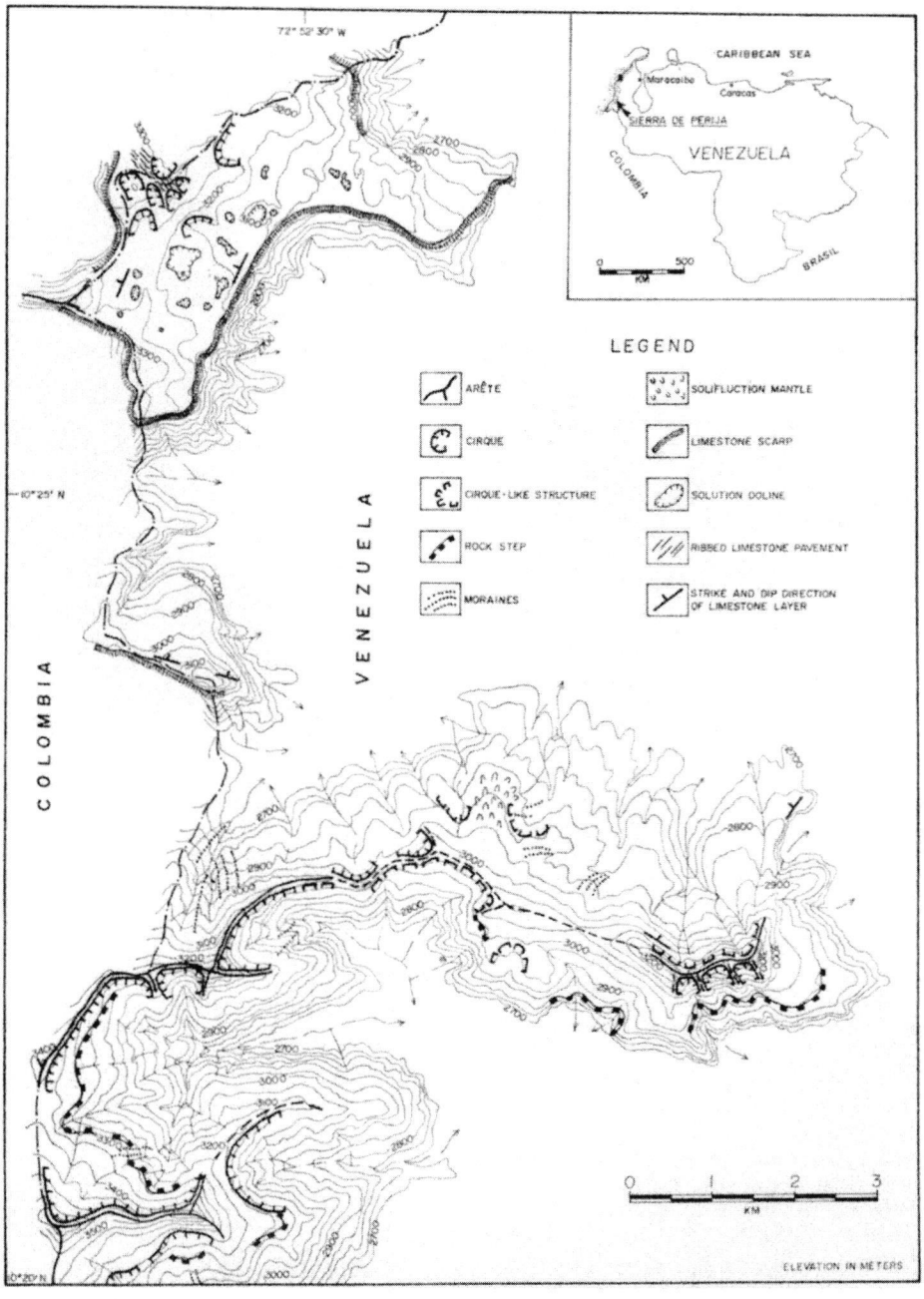

Figure 1: Glacial map of Cerro Pintado area, Sierra de Perijá, western Venezuela. Cerro Pintado is the southern half, and „Cerro Viruela" is the northern half.

approximately 2700 m elevation. The best developed cirques, however, are just below the highest ridges (arêtes). The cirque bottoms are at approximately 3000 to 3100 m, which represents the probable elevation of the late glacial snow line.

This is the first report of glacial features in yet another tropical mountain range, the Sierra de Perijá. They resemble those found in the Sierra de Mérida (Venezuelan Andes; SCHUBERT 1974), approximately 300 km southeast of the Sierra de Perijá, across the Lake Maracaibo Basin, which were tentatively assigned a Late Pleistocene age. Assuming that the Sierra de Perijá had reached its present elevation by the Late Pleistocene, the glacial erosional and depositional features described above, could possibly represent the equivalent of the lowest morainic level of the Sierra de Mérida (2600 to 2700 m), which were correlated with the maximum Wisconsin (Würm) glacial advance. Further work in the Sierra de Perijá, especially in terms of finding radiometrically datable material, should establish a firmer correlation with the Sierra de Mérida (southeast), and the Cordillera Oriental (south) and Sierra Nevada de Santa Marta (north), of Colombia (GONZÁLEZ et al. 1965; GANSSER 1955; RAASVELDT 1957).

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References

BOWEN, J. M.: Estratigrafía del pre-Cretáceo en la parte norte de la Sierra de Perijá. – Boletín de Geología (Venezuela), Pub. Esp. 5, 2, 1972, p. 729–761.

ESPEJO, A.: Excursión No. 2 – Sierra de Pirijá. – II Congreso Latinoamericano de Geología, Caracas 1973.

GANSSER, A.: Ein Beitrag zur Geologie und Petrographie der Sierra Nevada de Santa Marta (Kolumbien, Südamerika). – Schweiz. Min. u. Pet. Mitt., 35, 1955, p. 209–279.

GONZÁLEZ, E., VAN DER HAMMEN, T. & FLINT, R. F.: Late Quaternary glacial and vegetational sequence in Valle de Lagunillas, Sierra Nevada del Cocuy, Colombia. – Leidse Geol. Med., 32, 1965, p. 157–182.

HEA, J. & WHITMAN, A. B.: Estratigrafía y petrología de los sedimentos pre-cretácicos de la parte norte central de la Sierra de Perijá, Estado Zulia, Venezuela. – Boletín de Geología (Venezuela), Pub. Esp. 3, 1, 1960, p. 351–376.

HITCHCOCK, C. B.: The Sierra de Perijá, Venezuela. – Geographical Review, 44, 1954, p. 1–28.

MILLER, J. B.: Directrices tectónicas en la Sierra de Perijá y partes adyacentes de Venezuela y Colombia. – Boletín de Geología (Venezuela), Pub. Esp. 3, 2, 1960, p. 685–718.

RAASVELDT, H. C.: Las glaciaciones de la Sierra Nevada de Santa Marta. – Revista de la Academia Colombiana de Ciencias Físicas y Naturales, 9, 1957, p. 469–482.

SCHUBERT, C.: Geomorphology and glacier retreat in the Pico Bolívar area, Sierra Nevada de Mérida, Venezuela. – Z. Gletscherkde. Glazialgeol., 8, 1972, p. 189–202.

– : Late Pleistocene Mérida Glaciation, Venezuelan Andes. – Boreas, 3, 1974, p. 147–152.

SIEVERS, W.: Die Sierra Nevada de Santa Marta und die Sierra de Perijá. – Z. Gesell. f. Erdkunde Berlin, 23, 1888, p. 1–159.

Sociedad de Ciencias Naturales La Salle: La región de Perijá y sus habitantes. – Publicaciones de la Universidad del Zulia, Maracaibo 1953.

SUTTON, F. A.: Geology of Maracaibo Basin, Venezuela. – Bull. Amer. Assoc. Petrol. Geologists, 30, 1946, p. 1621–1741.

VILA, P.: Geografía de Venezuela. – Ministerio de Educación, Caracas 1960.

WALTER, H. & MEDINA, E.: Caracterización climática de Venezuela sobre la base de climadiagramas de estaciones particulares. – Boletín de la Sociedad Venezolana de Ciencias Naturales, 29, 1971, p. 211–240.

LANDSCHAFTSERHALTUNG UND MÖGLICHKEITEN ZUR INTENSIVIERUNG DER LANDNUTZUNG DURCH LEUCAENA LEUCOCEPHALA IM KABUPATEN SIKKA, FLORES[1])

Mit 4 Abbildungen und 4 Photos

JOACHIM METZNER

Summary: Land conservation and possibilities for agricultural intensification by *Leucaena Leucocephala* in Kabupaten Sikka, Flores.

The Leguminosae *Leucaena leucocephala* (Indonesian: Lamtoro) has been rediscovered for purposes of land conservation in Indonesia's driest province, Nusa Tenggara Timur. In Sikka on the isle of Flores Lamtoro has brought about a complete change in the agricultural landscape. Hedges of Lamtoro are planted along contour lines, which serve to halt erosion on the tuff soils of the volcanoes and which leads to the development of terraces behind them (so-called "indirect terracing"). The outstanding characteristics of Lamtoro are its deep root system, which is likely to improve soil structure, and its ability to fix nitrogen in the soil, thereby improving soil fertility. Thus it may form a basis for agricultural intensification. Having a high protein content its leaves may be used as a valuable fodder for a cattle- and buffalo-fattening scheme. Only a small portion of Sikka's population who live in the mountainous interior can be resettled on the few coastal plains. "Direct terracing", on the other hand, is very slow and not possible on all slopes. The Lamtoro scheme has thus to be regarded