

George P.L. Walker and his geological research in Iceland

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INTRODUCTION

The following brief obituary notice was presented at a meeting of the *Societas Scientiarum Islandica* (Vísindafélag Íslendinga) on 23 Feb 2005: "George Patrick Leonard Walker who was born 2 March 1926, grew up in London and Northern Ireland, and studied Geology at Queen's University, Belfast. He completed a Ph.D. at the University of Leeds in 1955. His thesis topic concerned the Early Tertiary igneous rocks of Northern Ireland, in particular their hydrothermal alteration minerals. He became Assistant Lecturer at Imperial College in 1951, Lecturer in 1954 and Reader in 1964.

In the summer of 1954 Walker visited Iceland and was impressed by the lava pile of its Eastern fjords. In the following summer he began his research on the strata in that region, and returned to Iceland every field season through 1965. Walker was really the first geologist to carry out simultaneous systematic mapping, in three dimensions, of many aspects of geology in Iceland. Previous research by Icelandic and foreign geologists had mostly either been directed at surface formations or at particular phenomena such as tephra deposits, fossils, glacial formations, or individual active volcanoes. In the early 1950's, others had initiated stratigraphic mapping e.g. with the aid of magnetic polarities in the lava pile of Iceland, but Walker introduced new methods which turned out to be very successful. His work was most thorough and accurate, and he revolutionized all thinking about the geological structure and genesis of Iceland. This applied not only to the inactive regions he was studying, but also to the younger active ones and the geothermal processes taking place there. Walker thus turned on its head the old saying of Geology: "The present is the key to the past".

The best known publications by Walker on Iceland include those on the geology of Reyðarfjörður in 1959, on zeolites in 1960, and on the Breiðdalur central volcano in 1963. In the paper on zeolites he touched on other topics such as the buildup of the lava pile, and the emplacement of intrusions in the volcanic zone accompanied by spreading and subsidence. He demonstrated that the geological history of Iceland was a continuous and indeed almost a steady-state process, rather than consisting of a few major episodes of different volcanic or tectonic upheavals as previously envisaged. Walker developed this view further in subsequent papers, including one with Gunnar Böðvarsson in 1964.

In addition to Walker himself, several of his graduate students carried out their field studies here, mostly in Eastern and Southeastern Iceland, and he also took part in collaborative projects based on his mapping. Of the numerous papers resulting from these efforts, three were published by the *Societas Scientiarum Islandica*.

Around 1965 Walker began research on the products of explosive volcanic eruptions worldwide, and he has stated that the Surtsey eruption contributed to his interest in these. This field of research brought him much recognition, just like his previous work on Iceland. Although his trips to Iceland became only intermittent after 1965, he kept writing important papers that were directly or indirectly connected with the geology of this country. In 1978 Walker accepted a research position in New Zealand for three years; he then moved to the University of Hawaii as Professor and investigated volcanoes in the Pacific region. He returned to England upon retiring in 1996.

Walker became a corresponding member of the *Societas Scientiarum Islandica* in 1968, he was

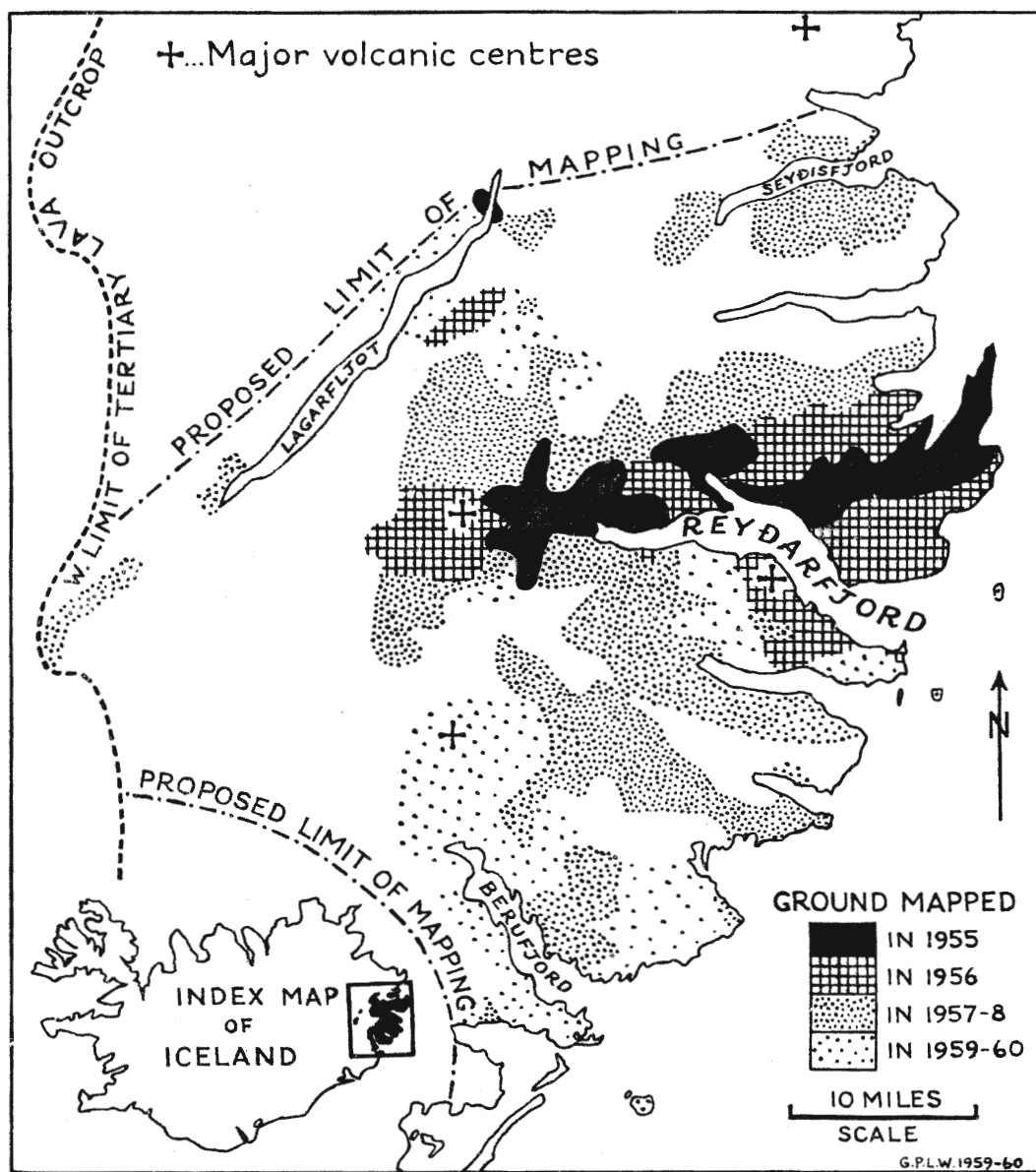


Figure 1. The map indicates areas studied by G.P.L. Walker (possibly also by his student I.S.E. Carmichael) during geological field work in 1955–1960. An area covered by Walker's student I.L. Gibson in 1960 does not seem to be included, cf. a map in Gibson's Ph.D. thesis. This diagram which was left with the author by the late T. Sigurgeirsson, may have accompanied Walker's correspondence with the Science Fund or the National Research Council of Iceland. –*Svæði sem G.P.L. Walker kannaði á Austurlandi 1955–1960.*



Figure 2. The U.K.-Icelandic paleomagnetic sampling expedition at its camp near the farm Bragðavellir in Álftafjörður, 1 Sept 1964. From left: George P.L. Walker and children from the farm, R.L. Wilson, N.D. Watkins, S.E. Haggerty, Gísli Þorsteinsson (cook), Jakob Yngvason (assistant), P.J. Smith, P. Dagley, and Leó Kristjánsson (assistant). –*Leiðangur til sýnasöfnunar í hraunlögum á Austurlandi, 1964.*

awarded the Order of the Falcon in 1980 and an honorary doctorate by the University of Iceland in 1988. He also received many honours abroad for his research and extensive teaching in mineralogy and volcanology. However, he remained a quiet man who did not seek the limelight. George Walker passed away on 17 January, leaving a wife and two children.”

The following notes recall sporadic contacts between the writer and George Walker, augmented with information from some correspondence and maps preserved at the University of Iceland. These notes should be looked upon as merely a few scattered pieces in the large mosaic picture represented by his unique influence on Icelandic geological research. Walker’s contributions include both direct ones resulting from his own field work here, and others emerging from graduate projects in Iceland supervised by him,

as well as from his studies elsewhere on volcanic processes, tectonics, secondary alteration of basalts, and so on. It would certainly be appropriate to make a comprehensive review of these contributions, but the present writer is far from having either the qualifications for such a task, or access to all the relevant literature. An excellent summary of Walker’s work to 1988 is already available (Imslund, 1988).

1954–1960

As mentioned above, Walker’s early research was carried out in the Tertiary basalt areas of Northern Ireland. In a newspaper interview (Morgunblaðið, 22 Oct 1988) he states that he initially came to Iceland in order to study amygdale minerals, feeling that his doctoral thesis on these minerals left various questions unanswered. During his visit to the Reyðarfjörður area in 1954 Walker noted the great thick-

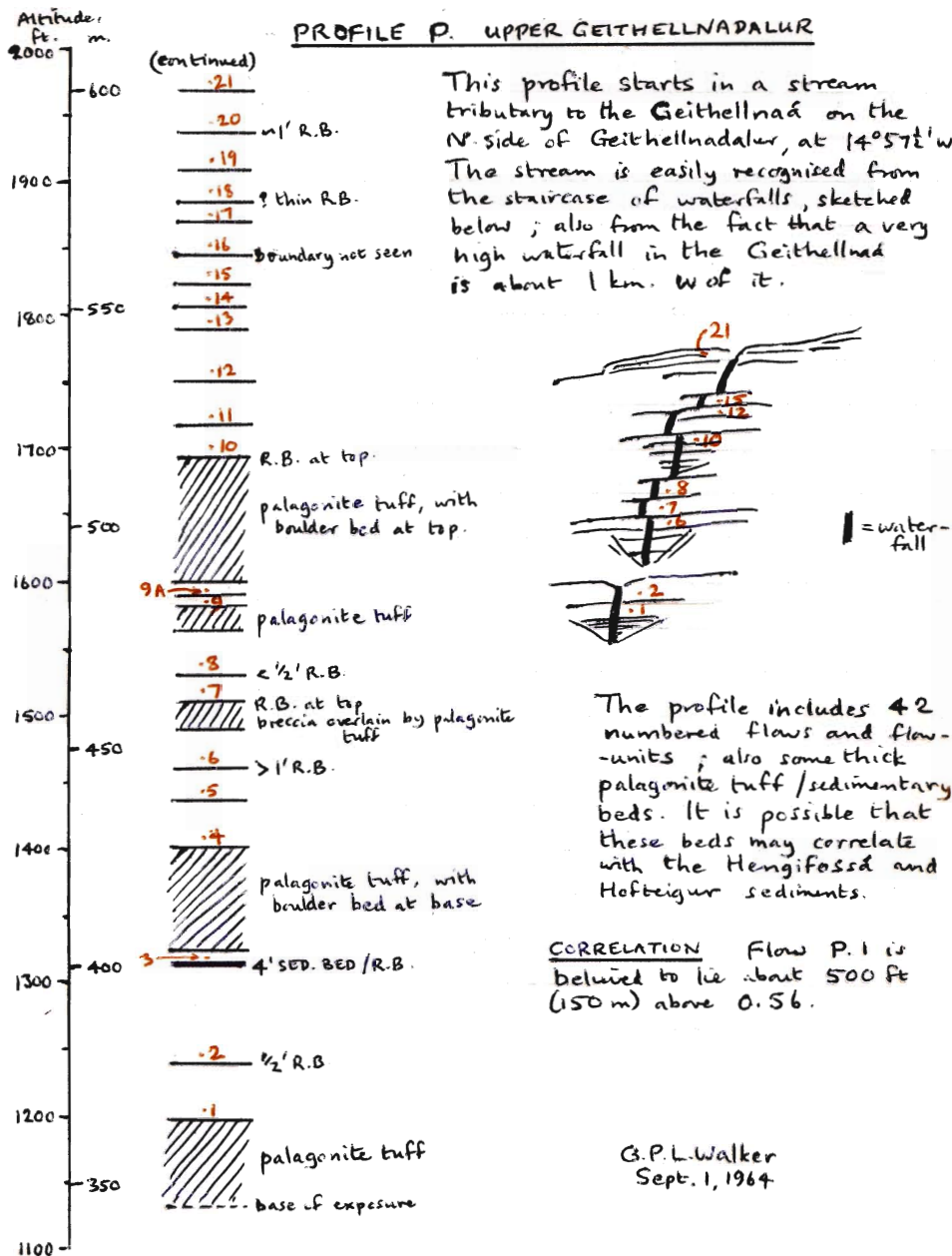


Figure 3. Walker's manuscript map of the bottom part of the paleomagnetic sampling profile P, Álftafjörður, Eastern Iceland. Original sheet size: 20 x 25 cm. This map and others like it were redrafted in a simplified format in the U.S. for Appendix I of Watkins and Walker (1977). – *Teikning Walkers af hluta sniðs í Álftafirði, 1964.*

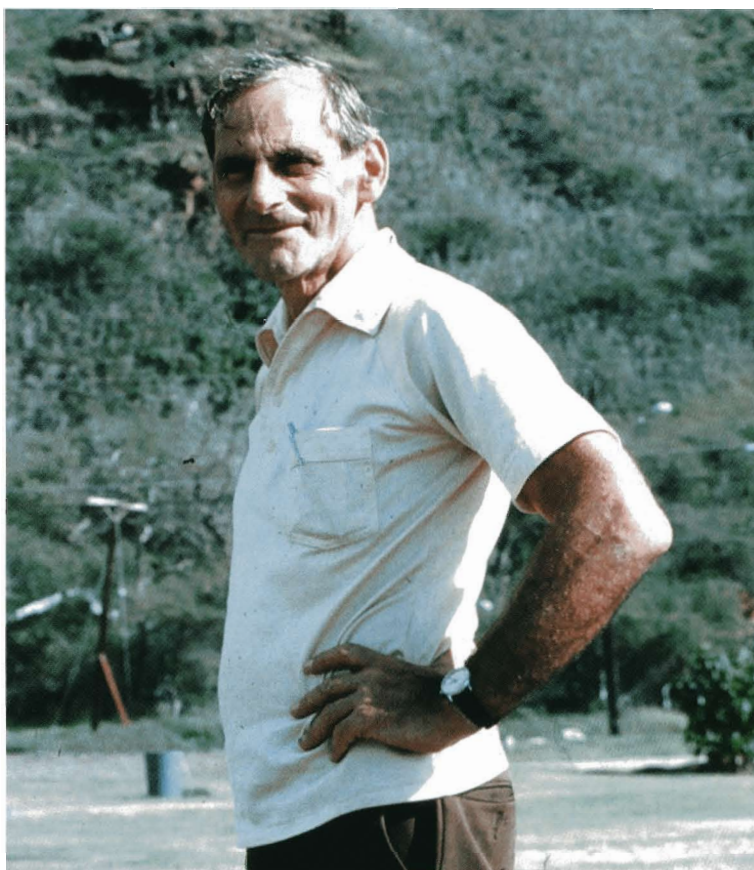


Figure 4. George P.L. Walker at Diamond Head, Hawaii, 26 Januar 1989 (Photo: L.K.)

ness of the basaltic strata, as compared to that of the Northern Ireland volcanic province. A short account of Walker's observations during 1955 was published (Walker, 1955).

In the interview just quoted, Walker states that his mapping took place in the area between Seyðisfjörður and Breiðamerkurjökull; the reference to Seyðisfjörður is interesting, because he does not appear to have published his observations from there or from the adjacent Mjóifjörður. However, in the writer's possession is a small-scale map confirming that he did carry out considerable work there, at least in 1957–1958 (Figure 1). On another undated manuscript map in scale 1: 100,000, the positions of

certain recognizable lava groups (such as the Vindháls porphyritic group and the Hólmar olivine group) have been traced in some detail south and west of Seyðisfjörður. The present author and his associates (Kristjansson *et al.*, 1995) have mapped stratigraphic profiles in Mjóifjörður and Seyðisfjörður. That paper is, however, a typical example of the differences between Walker's procedures and subsequent studies in the subaerially erupted lava pile of Iceland. Walker gives a picture of the lava pile that is three-dimensional to the full extent of available outcrops, whereas later work on the lava stratigraphy has mostly been confined to two-dimensional sections. The same may be said to apply to the distinction between Walker's work

on dikes and faults, zeolites, tectonic tilts, etc., and most other studies on such features in Iceland.

Walker's admirable research on central-volcano complexes was a key ingredient in the new understanding of the geology of Iceland. Although the existence of such features here had been implied by some earlier geologists (e.g. G.W. Tyrrell, see Kristjánsson, 1995), Walker was the first to demonstrate their existence and describe their main characteristics.

The Icelandic scientists Trausti Einarsson and Thorbjörn Sigurgeirsson had been studying magnetic remanence directions in Icelandic basalts since 1953, and Einarsson was applying them to extensive stratigraphic mapping in Southwestern and Eastern Iceland. Sigurgeirsson had contacts with P.M.S. Blackett of Imperial College who had become interested in planetary magnetism and the magnetic properties of rocks in connection with his Nobel prize-winning research on cosmic rays. Sigurgeirsson presumably learned about Walker's research in Eastern Iceland as soon as it began, through these contacts or the National Research Council of which he was director until 1957. Einarsson (1960) wrote a very favorable account of Walker's mapping work in Reyðarfjörður.

1961–1965

George Walker received grants from the Science Fund of Iceland in 1961–1963; these grants were probably very small in proportion to total costs of a field project like Walker's, but it was a rare distinction for a foreign scientist.

One of Walker's major contributions to improved understanding of the stratigraphy and tectonics of Iceland was his realization that the country had been formed by processes of crustal spreading. Walker and G. Böðvarsson, who was then at the State Electricity Authority, collaborated on an important paper on this matter (Böðvarsson and Walker, 1964). It was submitted just before the Vine and Matthews (1963) hypothesis on generation of the ocean floor appeared in print, and I expect independently of it. Some Icelandic geoscientists were sceptical of the spreading concept, for various reasons. It might be instructive to discuss these in detail but I shall only mention a few here: the traditional belief that Iceland was the remnant of a continent (supported by the presence of

acidic rocks); its oldest exposed rocks being thought to be of Eocene or even older age (until 1968); and the absence of vertical structures like those prominent in the Vine-Matthews model.

In early 1963, Sigurgeirsson discussed the possibility of a major sampling project in Iceland during a visit to Blackett's laboratory (see Kristjánsson, 1993). One of Blackett's former students, R. L. Wilson, wrote an application for the funding of such an expedition which eventually took place in 1964 and 1965. The 1964 sampling began in SW-Iceland in June, in profiles mapped by T. Einarsson. In the first days of August the party (Figure 2) set up camp near Neskaupstaður and began sampling in 15 lava profiles mapped by Walker. He painted a number on each lava, which greatly aided their correct identification. Additionally, Walker provided a diagram of each profile, with geological information and sometimes instructions regarding access. A complete set of his original 1964 drawings, dated between 25 July and 1 Sept. are in my possession, and one is reproduced here as Figure 3. They must have been made in his tent or his Land-Rover, and some were delivered only a day or two before the sampling of the respective profiles began. Invariably, they were very well done and certainly served their purpose. In July of 1965 Walker mapped another six profiles along the Norðurdalur valley of Fljótisdalur, for sampling by an expedition of smaller size.

1966–1977

Although Walker's main research emphasis shifted away from Iceland after 1965, he visited the country a number of times later. The instances which I recall include the 1974 conference on "The geodynamics of Iceland and the North Atlantic area" where he presented major new results and ideas about the country's geology and also about its deeper crustal structure. Subsequently, he published a paper (Walker, 1975) on areas in Iceland where the lower crust had been exposed by deep erosion, relating his findings to studies by others of ophiolites such as Troodos in Cyprus which had by then been accepted to represent slices of ocean crust and uppermost mantle rocks.

The 1964–1965 paleomagnetic sampling expedition in Iceland had been by far the largest single effort

of that kind in the world. The routine measurements of the samples, plus a number of smaller related studies, took several years to complete. However, preliminary results already published by Dagley *et al.* (1967), along with reliable radiometric dating in the following year, showed that the geomagnetic field had reversed its polarity at least 65 times in a period of some 11 million years. This important direct conclusion still stands, but has not been heeded by geomagnetists; they have since 1968 preferred basing their “polarity time scale” on interpretations of ocean-ridge magnetic lineations, a very indirect procedure involving many assumptions. As a result, the number of geomagnetic reversals, at least during the last 15 M.y., has always been underestimated by a factor of two or more.

Coming back to Walker’s profile drawings (Figure 2), I have rarely received stratigraphic diagrams of this quality with comparable speed from other geologists. One exception was John Preston (b. 1922) of Queen’s University of Belfast who carried out mapping of strata in the Arnarfjörður-Patreksfjörður area in 1970–1973. His previous research had included formations in Finland and Spitzbergen, but from around 1960 he also studied the Tertiary igneous rocks of Northern Ireland. Preston’s background was therefore quite similar to that of Walker; they were acquainted, and he later wrote review papers on the volcanic geology of Northern Ireland covering Walker’s contributions (e.g. Preston, 1982). We met a few times in 1972–1973 and collaborated on a paper containing his valuable observations. He mentioned to me in a letter in 1971, that authorities in Iceland would not permit him to investigate the central volcano north of Arnarfjörður. I expect that the reason for their decision was a desire to “preserve” such centers for future investigations by Icelandic scientists. As it happens, subsequent generations of geologists have not shown much interest in this or other extinct central volcanoes of Iceland: few detailed studies on them have been initiated since the mid-1970’s and almost none have been published. Only in the last few years has stratigraphic work been resumed in the region south of Arnarfjörður.

1978–1996

Walker (*pers. comm.*, 1980) told me that he would have liked to have more time to prepare the mapping for the 1964–1965 expedition, and to revise it later in the light of the paleomagnetic results. The distances between successive profiles were in two cases more than 50 km, and in a few other cases of the order of 10 km. It turns out that magnetic polarities in profile segments that were supposed to overlap in age did not always agree. An attempt was made to re-sample the four profiles in Norðfjörður in the early 1990’s, in part by a French team and in part by a group including Walker, but the results from these efforts were reported in the literature to only a limited extent (see Herrero-Bervera *et al.*, 1999). The sampling of another composite section through Eastern Iceland employing additional methods such as Ar-Ar dating, geochemical and isotope analysis, may well be worth considering.

Walker maintained an interest in investigations of lower crustal structure. Following my visit to him and paleomagnetists in Hawaii in 1989 (Figure 4), he wrote to me on 13 July 1990 describing his ideas about those intrusive complexes which he termed high-intensity ones, i.e. with more than 40% content of dikes and sheets. Walker considered these to be an important component of the crust at central volcanoes, and even of oceanic areas in general. In SE-Iceland, he added, there were fine and very accessible examples of intrusive complexes “just crying out to be studied by a whole range of techniques”. An accompanying map indicated favorable localities for such studies, including one exceptionally so in an unnamed tributary valley west of Kálfafellsdalur (64°10’N, 16°06’W). In areas where the basement consists of low-density rocks such as hyaloclastites and vesicular pahoehoe lavas, he expected that a coherent complex might form close to the surface. I am not aware whether Walker or others did embark on a project to investigate Icelandic intrusive complexes in the way he envisaged, which would have required considerable expenditures on field and laboratory work.

A final point in these disconnected reminiscences concerns a reprint I received from George Walker ten

years ago (Walker, 1995). His paper begins by recalling the Geikie-Judd controversy around 1890 regarding the nature of the volcanism in the British Tertiary Volcanic Province. This controversy did in fact have some connections with research in Iceland at that time (cf. Kristjánsson, 1995). Walker then goes on to discuss the historical and the modern findings on the North Atlantic volcanism, and suggests renewed efforts to resolve outstanding points. This paper is indeed characteristic of George Walker, demonstrating both his solid roots in classical traditions of British geology and his constant search for new approaches in the field of research to which he was so devoted.

A partial bibliographical list of papers by George Walker on Iceland's geology and some related subjects up to around 1980 is accessible at www.raunvis.hi.is/~leo. The list also includes various papers by his graduate students, as well as some joint papers by Walker and others based on his geological mapping in Iceland.

ÁGRIP

George P.L. Walker og jarðfræðirannsóknir hans á Íslandi

Grein þessi hefst á minningarorðum sem höfundur flutti á fundi í Vísindafélagi Íslendinga 23. feb. 2005, um dr. George P.L. Walker jarðfræðing (1926–2005) sem var bréfafélagi þess félags. Rætt er þar stuttlega um helstu verkefni í þeim rannsóknum Walkers sem hann stundaði á Íslandi frá 1955, og nefnd ýmis svið jarðfræði Íslands þar sem ritverk hans höfðu mjög mikil áhrif. Í greininni eru síðan rifjuð upp persónuleg kynni höfundar af George Walker og af öðrum vísindamönnum sem tengdust rannsóknum hans hér. Bent er á vefsíðu þar sem finna má skrá um margar áhugaverðar ritsmíðar Walkers, nemenda hans og samstarfsmanna, sem birtust á árabílinu frá 1950 til um 1980.

HEIMILDIR

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