

**The Southern Namibian Mapping Programme (SNMP) 2013 to 2022
– a decade of research collaboration and detailed mapping**

Anna Nguno¹ and Paul Macey^{2,3}

1. Geological Survey of Namibia, 6 Aviation Road, Windhoek <Anna.Nguno@mme.gov.na>
2. Council for Geoscience, Western Cape Regional Office, 3 Oos Street, Bellville 7530, South Africa
3. Department of Geological Sciences, University of Cape Town, Rondebosch 7701, South Africa
<macero72@gmail.com>

Abstract :- Geological mapping and research has been carried out in Namibia since the early 1900s, resulting in a rather heterogenous information coverage. Also, in the 1990s and early 2000s stagnation of field mapping led to little new data being generated by the Geological Survey, although archival data were captured electronically and made available in digital and hardcopy format. In 2013, a co-operation/contract project between the Geological Survey of Namibia and the Council for Geoscience (South Africa) was initiated to remap the Meso- and Palaeoproterozoic rocks of the Warmbad area, //Karas Region (southern Namibia) - a programme which combined the acquisition of more detailed geological maps and geoscientific research with training and capacity building at both the Namibian and South African geological surveys. Its initial contract fulfilled, the project's activities expanded to other parts of the highly prospective //Karas Region, and over the following decade produced ninety-five 1:50 000 scale geological maps, with accompanying reports and associated geochemical, geochronological and structural data, plus a number of research publications, conference abstracts and post-graduate theses.

Keywords :- Mapping, Research collaboration, Capacity building, Geoscience outreach

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Background

Geological maps and associated research products provide base information for a wide range of applications, most notably minerals exploration, but also for finding groundwater resources, infrastructure development and environmental investigations (including climate change and geohazards), as well as for promoting geotourism and geoheritage-related activities. Regional geological mapping at various scales has been carried out by the Geological Survey of Namibia (GSN), and its predecessors, for more than a century, complemented by the work of local and international research institutions and mining / mineral exploration companies. A highly heterogeneous geological map coverage and information base for the country resulted, with some areas surveyed in great detail, others mapped only at reconnaissance level, and the Cenozoic generally receiving little attention. With the advent of GIS, these archival geological data were compiled into 1:250 000 and 1:100 000 scale digital maps covering some two thirds of the country, excepting only

the largely sand-covered northeast (Fig. 1).

However, understaffing and a lack of experienced personnel at GSN caused new geological mapping of the country to lag since the 1990s. Therefore, in 2013 GSN embarked on a new, systematic and higher detail 1:50 000 scale regional geological mapping programme combining contract mapping by experienced senior geologists of the Council for Geoscience (CGS) and training of GSN staff in modern mapping and map production techniques. The //Karas Region of southern Namibia was selected as the first focal area, because the geologically complex Precambrian Namaqua and Gariiep rocks are highly prospective for a wide range of mineralisation types and commodities. Furthermore, previous mapping of the area was completed at 1:100 000 to 1:250 000 scale more than 40 years earlier and therefore due for revision applying modern research and mapping techniques, and scientific insights. Developing a unified stratigraphy across the Orange River was another important objective of the project.

Project Implementation

The Southern Namibia Mapping Programme (SNMP) was carried out by a team of mapping geologists from GSN and CGS, supported by Namibian and South African university students and academics. Annual activities followed a standard mapping workflow starting with database construction and remote sensing. Comprehensive ArcGIS geospatial databases of archival and published geological maps, as well as data from research publications and these were overlaid with satellite and airborne geophysical and multi- / hyperspectral imagery for the compilation of base maps for field mapping. Lithological and structural mapping (>30 000 structural readings) and sample collection campaigns were carried out by both senior and junior geologists from mobile tented base camps. Field observations and measurements were captured into new geospatial databases and many thousands of digital photographs linked to waypoint locations. Analytical work included petrography, whole rock major, trace and REE geochemistry (~950 samples), stable (O, C) and

radiogenic (Sm, Rb, Hf) isotope geochemistry (>500 analyses), P-T pseudo-section studies and U-Pb zircon, monazite and titanite geochronology (236 samples; Table 1). Thin section preparation, whole rock geochemical analyses and zircon separation were done at the CGS laboratory (Pretoria), while isotope analyses, metamorphic studies and U-Pb dating were carried out at the Universities of Cape Town and Stellenbosch (South Africa) and Curtin University (Australia), respectively. Field and laboratory data were integrated into 1:50 000 scale geological maps and explanatory reports. Map compilation by the CGS Spatial Data Management Unit involved training of GSN staff in modern cartographic techniques, with the last maps being produced at GSN. The project received assistance from the Ministry of Environment, Forestry and Tourism, local farmers and mineral licences holders, who facilitated access to the land; in addition, NAMDEB provided in-kind support during work in the Tsau //Khaeb (Sperrgebiet) National Park.

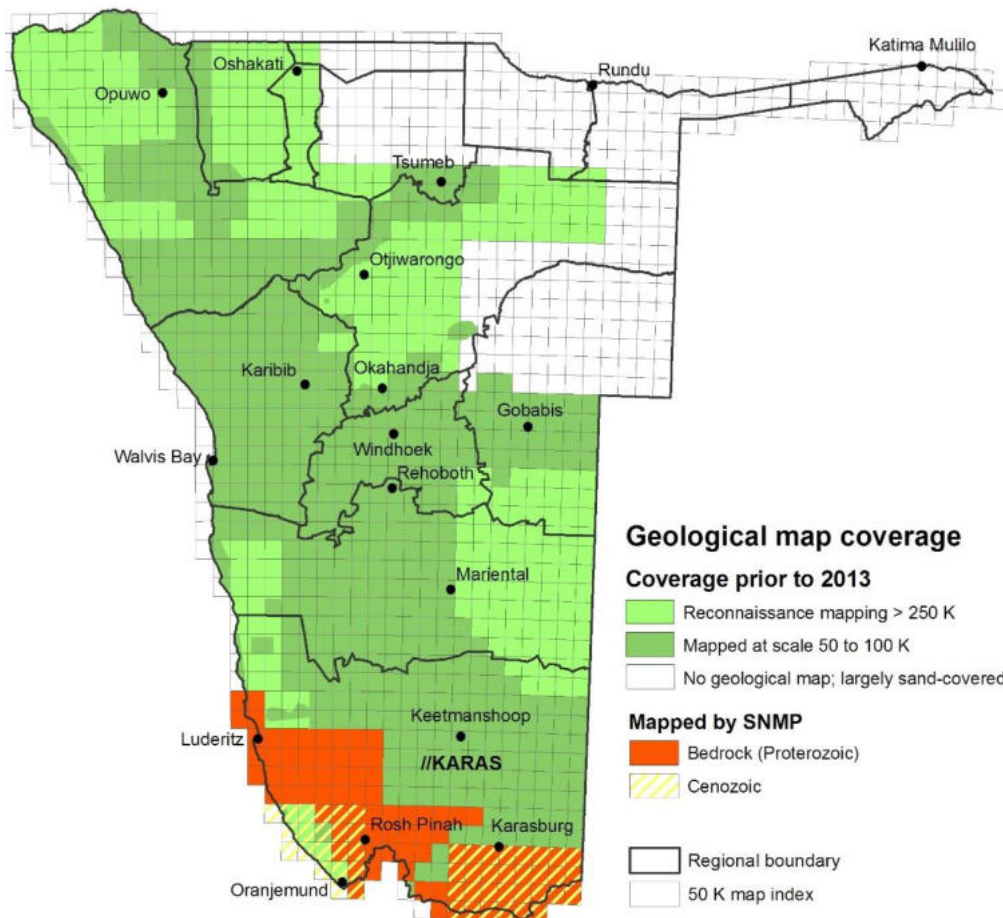


Figure 1. Geological map coverage prior to 2013 and areas mapped by the SNMP

Progressive phases of the SNMP:

- 1:50 000 scale geological mapping of the Palaeo- and Mesoproterozoic Namaqua Metamorphic Province in the areas of
 - ✓ Warmbad, Ariamsvlei and Haib (2013-2015)
 - ✓ East of Rosh Pinah (Namuskluft), central Sperrgebiet (Aurus Mountains) and Grünau (2015)
 - ✓ Lower Fish River and Konkiep canyons, Ai-Ais and Huns Mountains (2015-2017)
 - ✓ Aussenkjer (2019; including the Cambrian Kuboos-Bremen line of intrusives)
 - ✓ Lüderitz and Aus (including Aukam valley (2019-2021)
 - ✓ Hottentot Bay north of Lüderitz (2021)
- 1:50 000 scale geological mapping of the Neoproterozoic Port Nolloth Group (Port Nolloth Zone, Gariep Belt) in the
 - ✓ Rosh Pinah, Namuskluft and Witputs areas (2016-2017)
 - ✓ Northern Sperrgebiet (2019-2021)
- 1:250 000 scale reconnaissance mapping of the Cenozoic geology of the
 - ✓ 2818 Warmbad map sheet
 - ✓ southern Sperrgebiet north of Oranjemund
- Training and supervision of GSN staff in modern mapping and research techniques by gradually transferring responsibility:
 - ✓ Mapping by CGS geologists accompanied by GSN staff
 - ✓ Mapping by CGS geologists in tandem with GSN colleagues
 - ✓ Mapping by GSN geologists under limited supervision from CGS staff

Area	Mapped by (GSN : CGS)	Period	Samples collected	Thin sections	U-Pb Geochronology	XRF+ICPMS major/trace/RE elements	Sr	Nd	Structural measurements	C, O Stable isotopes
Warmbad	30% : 70%	2013-15	1700	678	86	512	54	54	11612	0
Ariamsvlei	10% : 90%	2015	41	<i>no info</i>	0	0	0	0	672	0
Haib	90% : 10%	2015	81	<i>no info</i>	1	8	0	0	720	0
Namuskluft	0% : 100%	2015	117	<i>no info</i>	14	31	0	0	1383	0
Sperrgebiet	0% : 100%	2015	121	<i>no info</i>	15	56	0	0	1121	0
Grünau	20% : 80%	2015	105	<i>no info</i>	7	19	0	4	251	0
Lower Fish River Canyon/Ai-Ais	25% : 75%	2015	315	<i>no info</i>	20	65	14	19	758	0
Upper Fish River Canyon/Konkiep	35% : 65%	2016	264	82	21	54	0	7	2697	0
Gariep	25% : 75%	2016-17	238	57	8	11	0	0	2653	252
Huns Mountains	25% : 75%	2017	0		3	0	0	0	252	0
Aussenkjer	30% : 70%	2019	146	23	2	13	0	0	549	0
Lüderitz & N Sperrgebiet, Aus area	45% : 55%	2019-21	307	211	47	165	7	7	8373	112
Hottentot Bay	20% : 80%	2021	74	38	12	23	1	1	394	0
Total	30% : 70%	2013-22	3509	1089	236	957	76	92	31435	364

Table 1. Areas mapped and data generated by the SNMP during the period 2013-2022

Maps and Associated Products

In the ten years of collaboration and co-operation between CGS and GSN ninety-five full and partial 1 : 50 000 scale geological maps were produced, with the actually mapped terrain covering some 45 000 km² or ~5.5 % of the country's surface area (Figs 1, 2). All maps are fully digital and include point (structure, lithology, geochronology), line (lithology, structure) and polygon (lithology) data, with each coded feature having queryable attributes including

information on tectonostratigraphy, lithostratigraphy, age, meta-morphic grade and rock type. Several of the areas, such as the environs of Lüderitz, Hottentot Bay to the north of that town and the Aurus Mountains of the central Sperrgebiet (Fig. 3) were mapped for the first time in any kind of detail, requiring the introduction of a whole new set of stratigraphic units and names.

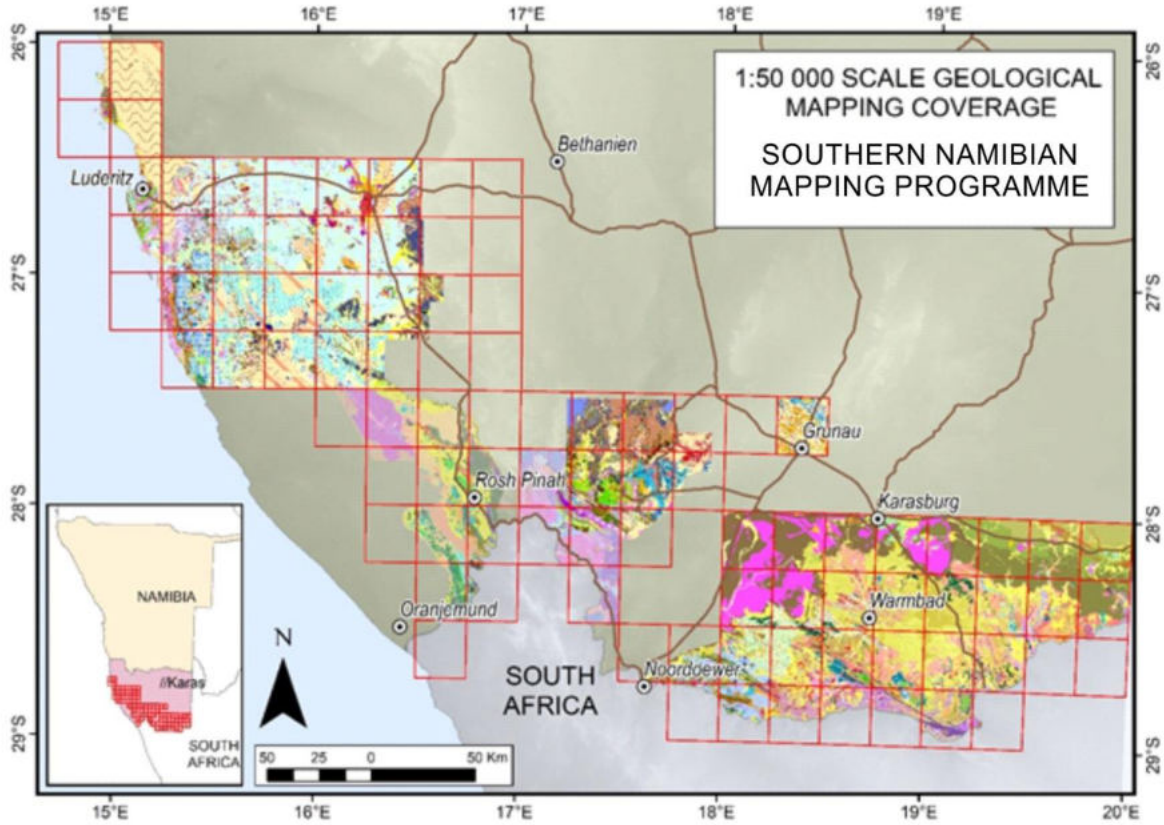


Figure 2. Areas mapped in detail by the SNMP between 2013 and 2022

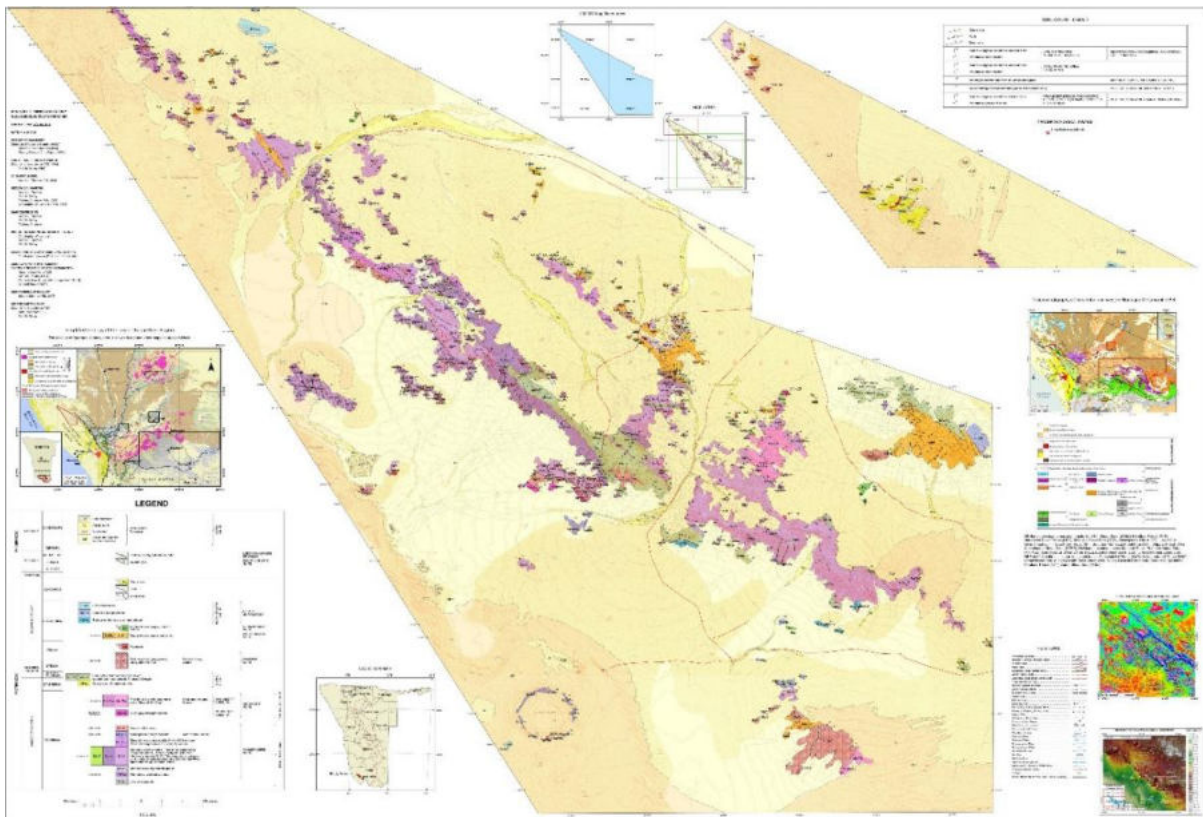


Figure 3. New 1: 50 000 scale geological map of the Aurus Mountains, central Sperrgebiet

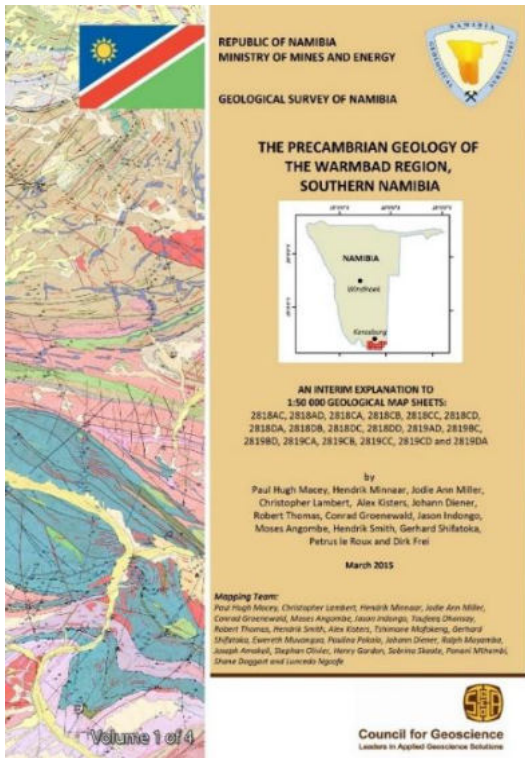


Figure 4. Map sheet explanations and mapping report compiled by the SNMP

Maps are accompanied by comprehensive reports (e. g. Macey *et al.*, 2015, 2020, 2022; Thomas *et al.*, 2016; Gresse *et al.*, 2016, 2018), Shifotoka and Indongo, 2017) describing the main rock types and geological structures of the area within the context of new tectonic and stratigraphic subdivisions and geological models based on observed field relationships and new analytical data (Fig. 4). In addition to 1:50 000 scale “hard rock” maps, two 1:250 000 scale maps with explanations featuring the Cenozoic geology of the Warmbad area (Gresse and Mhopjeni, 2015) and the southern Sperrgebiet (Gresse and Nduutepo, 2020), respectively, were compiled. Incorporating the new map data, so far three 1:250 000 scale geological maps (2818 Warmbad, 2816 Oranjemund and 2716 Ai-Ais) have been updated. And lastly, a 1:40 000 scale hiking and geological map of the Fish River Canyon, one of the country’s best-known geological landmarks and tourist attractions was produced in cooperation with Slingsby Maps, South Africa (Fig. 5).

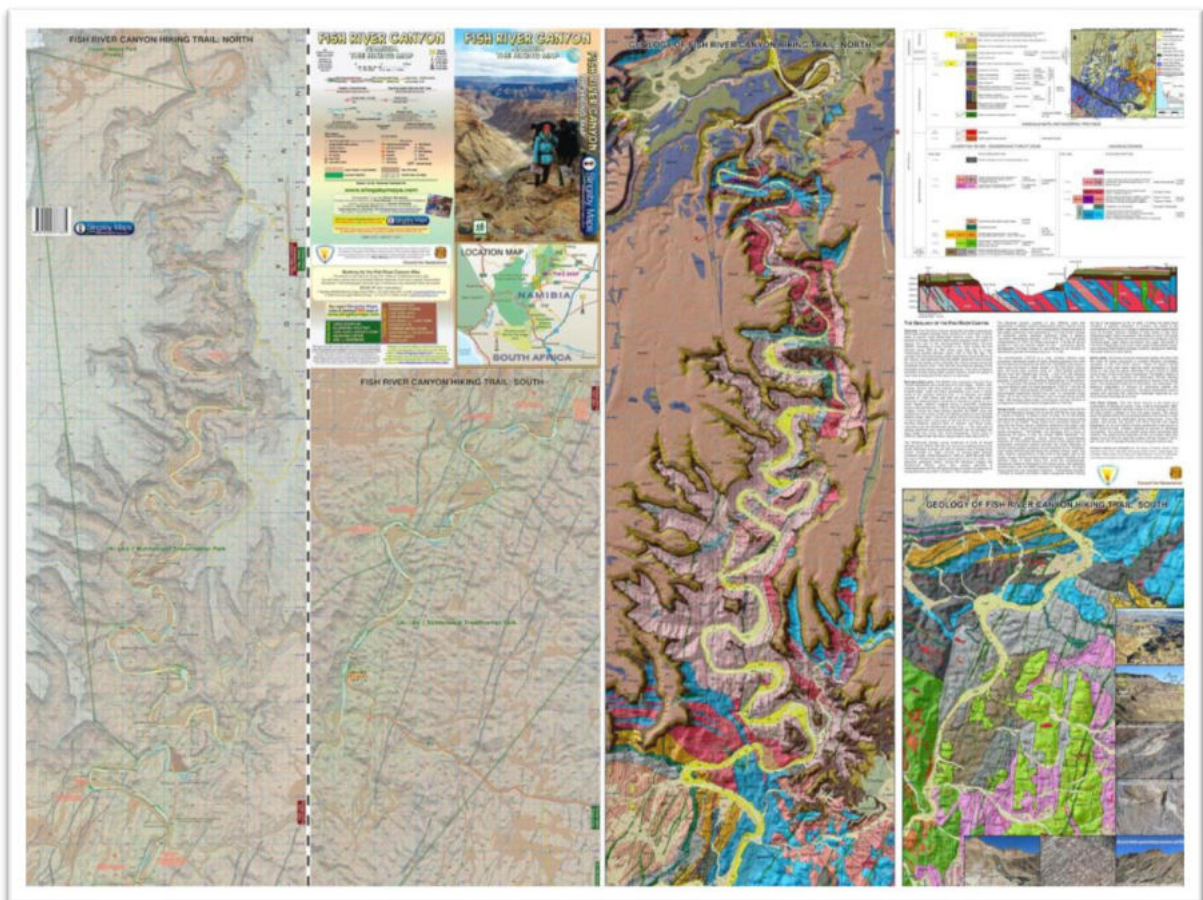


Figure 5. Hiking and Geological Map of the Fish River Canyon

Scientific Achievements

Regional mapping formed the basis for collaboration with university researchers and post-graduate students, which resulted in seventeen publications in international journals (Appendix A) and 41 conference abstracts (Appendix B). Eighteen post-graduate research projects (Appendix C) were completed as part of the SNMP, including twelve BSc (Hons) and five MSc theses from the University of Stellenbosch (South Africa), Cape Town (South Africa), Western Cape (South Africa), the University of Namibia and McGill University (Canada), as well as one PhD from McGill University.

Among the scientific achievements of the SNMP is the proposal of an alternative theory for the amalgamation of the southern African portion of the Rodinia supercontinent during the Mesoproterozoic, which favours a model of crustal reworking (Macey *et al.*, 2015) over the traditional accretion of crustal terranes (e. g. Hartnady *et al.*, 1985; Joubert, 1986; Colliston and Schoch, 2013). This hypothesis in turn led to a redefinition of crustal segments within the Namibian part of the Namaqua – Natal Meta-

morphic Province, which are from north to south the Konkiep Domain, the Kakamas Domain, the Aus Domain and the Richtersveld Magmatic Arc (Fig. 6). Structural mapping recognised significant late-Namaqua (~1100 Ma) deformation (Eureka and Sperlingsputs Shear Zones - Angombe, 2016; Indongo, 2017), while U-Pb zircon dating identified a new intrusive suite (Orange Falls Suite) younger by some 650 Ma than the Vioolsdrif granitoids with which it was previously grouped, as well as the first Archaean-derived rocks within the Namaqua Metamorphic Province of Namibia, i. e. the Bankwasser Migmatite Complex west of Warmbad and the Blue Mountain Group metapelites of the Hottentot Bay area (Doggart *et al.*, 2023). In the Port Nolloth Zone of the Gariiep Orogenic Belt detailed mapping also produced a new subdivision into a number of depositional and structural subzones, with special emphasis being placed on the correlation of the various diamictite deposits (Gresse *et al.*, 2018), denoting global glaciation events (“Snowball earth”; Table 2).

BASINAL ZONE (WEST)				THRUST ZONE				RIFT ZONE				PLATFORM ZONE (EAST)			Glaciation/ Deglaciation Sequence
Subgroup	Formation	Member	Igneous Complex/ Suite	Sub- group	Formation	Member	Igneous Complex/ Suite	Subgroup	Formation	Member	Igneous Complex/ Suite	Subgroup	Formation	Member	
Holgat	Daberas			Holgat	Daberas	Dreigratberg		Holgat	Daberas	Dreigratberg		Holgat	Uguchab	Dreigratberg	Cap carbonate 3
										Namuskluft	Marinoan (635 Ma)				
		Bloeddrif				Bloeddrif				Bloeddrif	Cap carbonate 2				
	Numees	Jakkalsberg			Numees	Jakkalsberg			Numees				Numees		Sturtian (720 Ma)
Hilda	Dabie River			Hilda	Dabie River			Hilda	Dabie River			Hilda	Dabie River		
	Wallekraal	Koivib			Wallekraal				Wallekraal						
	Pickelhaube Peak	Spitskop/ Koivib			Pickelhaube Peak	Pickelhaube Peak			Pickelhaube Peak	Pickelhaube Peak					
	Rosh Pinah	Obib	Koivib		Rosh Pinah	Gergarub Een Oog	Spitskop/ Koivib		Rosh Pinah	Een Oog	Spitskop				
	Kaigas								Kaigas	Trekpoort			Kaigas	Trekpoort	Cap carbonate 1
Stinkfontein	Gumchavb		Koivib					Stinkfontein	Vredefontein			Stinkfontein	Vredefontein		Kaigas (>760 Ma)

Table 2. Stratigraphy of the Port Nolloth Group, Gariiep Supergroup, as refined by new detail mapping

Community Outreach in the //Karas Region

Objectives, achievements and expectations of the SNMP were presented to dignitaries of the //Karas Region and stakeholders during a two-day outreach event in August 2018 at the Ai-Ais Hot Spring Resort. Main aim of the occasion was the launch of the new detailed 1:50

000 scale maps and related research products (Fig. 7), to generate a better understanding of the many benefits of reliable geological information among officials and the public, and to emphasise the significance of cross-border collaboration in the field of geoscience.

In the ten years of SNMP activities, a number of challenges were encountered not the least of which was the COVID-19 pandemic, which delayed both field and laboratory work with repeated lockdowns and travel restrictions. Apart from *force majeure*, the tight time frame and financial constraints occasionally required some ingenuity to make ends meet and extract the maximum benefit from the available resources.

On the technical side, some difficulty arose from the failure to set up strict symbology codes and data base attributes for the new data.

To enable the smooth integration of newly mapped areas into an existing geological map coverage and data base, it is essential to stipulate certain guidelines, especially with regard to naming and symbolisation of newly identified geological units, at the outset of any major project of this kind. Rectification of ambiguities created by the absence of such norms, involving the renaming of units, changing of codes and colours, editing of reports and revision of map layouts and data base attributes, is a time-consuming and exacting task, which can be avoided by adherence to specified standards.

Conclusions

During the past decade the Southern Namibian Mapping Programme has contributed significantly to the long-term national geoscience objective of acquiring detailed (1:50 000 scale) geological map coverage for the entire country. Despite temporary setbacks and some stumbling blocks, the fact that the SNMP - initially tasked only with remapping the Palaeo- to Mesoproterozoic geology of the Warmbad area over a period of three years - continued for an entire decade, moving in scope far beyond its original boundaries, alone is indication of its success. Many of the Project's findings and conclusions featured at a special session during the 29th Colloquium of African Geology, which took place in Windhoek in September 2023, covering aspects of mineralisation, structure,

metamorphism and stratigraphy, as well as GIS – related problems, the application of remote sensing in mapping and matters of project management. If the theories evolved from the new data may not all be uncontended, the data and maps themselves provide a solid footing on which to build mineralisation models for exploration, new hypotheses for geotectonic evolution, as well as development plans for infrastructure and land use. As shown by the close co-operation between the contract partners, major mapping programmes, such as SNMP, provide a platform for government and research institutions to collaborate on common objectives, share data and exchange expertise, with enhanced capacity and know-how not the least of many benefits.

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Appendix A. Peer-reviewed publications in international journals (in chronological order)

Melosh, B.L. Rowe, C.D., Smit, L., Groenewald, C., Lambert, C.W. and Macey, P. 2014. Snap, Crackle, Pop: Dilational fault breccias record seismic slip below the brittle-plastic transition. <i>Earth and Planetary Science Letters</i> , 403 , 432-445.
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Diener, J.F.A. and Macey, P.H. 2023 (in press). Pervasive and uniform low-pressure granulite facies conditions in the Grünau–Kakamas Domain, Namaqua–Natal Province, Namibia: A manifestation of thermal buffering during partial melting? <i>Journal of Metamorphic Geology</i> .

Appendix B. Conference abstracts produced by the SNMP (in chronological order)

Lambert, C., Groenewald, C., Macey, P.H., Kisters, A. and Frei, D. 2013. Melt migration along transcurrent shear zones: Case Study of the Pofadder Shear Zone and the Skimmelberg Pegmatite Stockwork (Poster). <i>24th Colloquium of African Geology</i> , 8-14 Jan., Addis Ababa, Ethiopia.
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Lambert, C.W., Kisters, A. F.M., Macey, P. H., Frei, D., Buick, I.S. and Groenewald, C. 2013. Melt-shear zone relationships during the lifespan of a continental transcurrent shear zone. <i>GSA Annual Meeting, 27-30 Oct., Denver USA</i> .
Lambert, C.W., Macey, P.H., Kisters, A.F.M., Groenewald, C.A., Frei, D., Buick, I.S. and Angombe, M. 2014. The Marshall Rocks-Pofadder Shear Zone and other Late-Namaqua shear zones: 45 million years of progressive deformation in the western Namaqualand Metamorphic Province. <i>Roy Miller Symposium, 18-30 Aug., Windhoek Namibia, 42</i> .
Macey, P.H., Minnaar, H., Miller, J.A., Lambert, C., Groenewald, C., Diener, J., Dhansay, T., Mofokeng, T., Le Roux, P., Muvangua, E., Indongo, J., Angombe, M., Frei, D., Ngcofe, L., Smith, H., Olivier, S., Mbtembi, P., Pokolo P., Shifotoka, G., Muyamba, R. and Amakali, J. 2014. Tracing Tectonic Terranes in Southern Namibia (Poster). <i>Roy Miller Symposium, 18-30 Aug., Windhoek, Namibia, 67</i> .
Angombe, M., Macey, P.H. and Miller, J.A. 2014. The Eureka Shear Zone (Poster). <i>Roy Miller Symposium, 18-30 Aug., Windhoek, Namibia, 59</i> .
Indongo, J. 2014. The Lithostratigraphy, Structure and Age of the Southern Namaqua Front and its Country Rocks Southern Namibia (Poster). <i>Roy Miller Symposium, 18-30 Aug., Windhoek, Namibia, 64</i> .
Shifotoka, G. 2014. The Orange Falls Suite, a newly recognised syntectonic granitoid suite (Poster). <i>Roy Miller Symposium, 18-30 Aug., Windhoek, Namibia, 74</i> .
Smith, H., Miller, J.A., Macey, P.H. and Olivier, S. 2014. The emplacement and evolution of the Keimasmund Complex, Warmbad, Southern Namibia (Poster). <i>Roy Miller Symposium, 18-30 Aug., Windhoek, Namibia, 77</i> .
Miller, J., Macey, P., Lambert, C., Le Roux, P., Shifotoka, G. and Frei, D. 2015. Cannibalisation of Palaeoproterozoic Arc Terranes during the Mesoproterozoic in the Namaqua Metamorphic Belt, Southern Africa. <i>25th Annual Goldschmidt Conference, 16-21 Aug., Prague, Czech Republic</i> .
Macey, P.H., Lambert, C.W., Kisters, A.F.M., Gresse, P.G., Thomas, R., Miller, J.A., Groenewald, C., Angombe, M., Indongo, J., Shifotoka, G., Minnaar, H., Smith H., Dhansay, T., Diener, J., Frei, D., Muvangua, E., Spencer, C., Le Roux, P. and Doggart, S. 2016. Towards a new geodynamic model for the western Namaqua Province. <i>International Geological Congress 35, 27 Aug. - 4 Sep., Cape Town, South Africa</i> .
Thomas, R.J., Macey, P.H., Spencer, C, Dhansay, T. and Lambert, C. 2016. Geological evolution of the Auru Mountains, Sperrgebiet Domain, Namibia. <i>International Geological Congress 35, 27 Aug. - 4 Sep., Cape Town, South Africa</i> .
Lambert, C.W, Macey, P.H., Kisters, A.F.M., Groenewald, C.A., Frei, D., Buick, I.S. and Angombe, M. 2016. The Marshall Rocks-Pofadder Shear Zone and other late-Namaqua dextral shear zones between Ai-Ais and Pofadder in the western Namaqualand Metamorphic Province: Fabrics, timing and late stage melt controls. <i>International Geological Congress 35, 27 Aug. - 4 Sep., Cape Town, South Africa</i> .
Shifotoka, G., Haimbodi, M., Macey, P.H., Miller, J.A. and Thomas, R. 2016. The Regional Geological Setting of the Haib Porphyry-Copper Deposit, southern Namibia (Poster). <i>International Geological Congress 35, 27 Aug. - 4 Sep., Cape Town, South Africa</i> .
Miller, J.A., Macey, P.H., Lambert, C.W., Angombe, M., Shifotoka, G., Thomas, R.J., Frei, D. and Le Roux, P. 2016. Reassessment of Mesoproterozoic granitic rocks in southern Namibia and their context within the broader western Namaqua Province. <i>International Geological Congress 35, 27 Aug. - 4 Sep., Cape Town, South Africa</i> .
Miller, J.A., Macey, P.H., Lambert, C.W., Frei, D., Le Roux, P. and Muvangua, E. 2016. Distribution and characteristics of gabbros, gabbro-norites and amphibolites across the western Namaqua Province and their role in constraining terrane boundaries. <i>International Geological Congress 35, 27 Aug. - 4 Sep., Cape Town, South Africa</i> .
Indongo, J., Macey, P.H., Miller, J.A. and Shifotoka, G. 2016. The late-Namaqua Sperlingsputs Shear Zone System Haib region, southern Namibia. <i>International Geological Congress 35, 27 Aug. - 4 Sep., Cape Town, South Africa</i> .
Angombe, M., Macey, P.H., Miller, J.A. and Lambert, C.W. 2016. The lithostratigraphy and structural components of the Eureka Shear Zone, southern Namibia. <i>International Geological Congress 35, 27 Aug. - 4 Sep., Cape Town, South Africa</i> .
Smith, H.P., Macey, P.H., Miller, J.A., Rowe, C., Lambert, C.W., Diener, J. and Frei, D. 2016. The Lower Fish-River / Onseepkans Thrust Zone: Time constraints and insights into Namaquan thrust tectonics. <i>International Geological Congress 35, 27 Aug. - 4 Sep., Cape Town, South Africa</i> .
Doggart, S.W., Buick, I., Frei, D., Lana, C., Macey, P.H. and Lambert, C.W. 2017. Monazite U/Pb geochronology and Sm/Nd isotope geochemistry of the Orange River pegmatite belt; a late stage felsic melt emplacement in the Namaqua Metamorphic Complex. <i>Igneous & Metamorphic Studies Group (ISMG) Conference, Johannesburg, South Africa</i> .
Diener, J.F.A. and Macey, P.H. 2018. Pervasive and uniform Low-P Granulite facies conditions in the Grünau-Kakamas Domain: A Manifestation of thermal buffering during partial melting? <i>Igneous & Metamorphic Studies Group (ISMG) Conference, University of the Western Cape (Bellville), South Africa</i> .
Macey, P.H. and Slingsby, P. 2018. A hiking and geology map of the Fish River Canyon (Poster). <i>Geocongress, 18-20 July, Johannesburg, South Africa</i> .

Doggart, S.W., Buick, I., Macey, P.H., Lambert, C.W., Lana, C., Frei, D. and Angombe, M. 2019. A new perspective on the origins of the Orange River Pegmatite Belt. <i>Geological Society of Namibia 50th Anniversary Conference</i> , 1-4 Sep., Windhoek, Namibia, 63.
Macey, P.H., Lambert, C.W., Thomas, R.J., Miller, J.A., Angombe, M., Smith, H., Indongo, J., Shifotoka, G., Nguno A., Minnaar, H., Groenewald, C.A., Muvangua, E., Dhansay, T., Doggart, S., Diener, J.F.A., Kisters, A.F.M, Frei D., Spencer, C., Bracciali, L., Le Roux, P., Musekiwa, C., Pokolo, P., Muyamba, R., Amakali, J., Rowe, C., Melosh B., Hartnady, M. and Tinguely, C.. 2019. The Namaqua Metamorphic Province: New perspectives from southern Namibia. <i>Geological Society of Namibia 50th Anniversary Conference</i> , 1-4 Sep., Windhoek, Namibia, 67-68.
Smith, H.P., Macey, P.H., Miller, J.A., Angombe, M., Lambert, C.W. and Rowe, C. 2019. Timing and characterisation of the 1200 - 1100 Ma tectonism in the Namaqua Metamorphic Complex, southern Namibia <i>Geological Society of Namibia 50th Anniversary Conference</i> , 1-4 Sep., Windhoek, Namibia, 69-70.
Indongo, J. 2019. The lithological and structural characterisation of the Sperlingsputs Shear Zone in southern Namibia (Poster). <i>Geological Society of Namibia 50th Anniversary Conference</i> , 1-4 Sep., Windhoek, Namibia, 84.
Shifotoka, G., Macey, P.H., Haimbodi, M., Miller, J.A. and Thomas, R. 2019. The regional geological setting of the Haib porphyry-copper deposits, southern Namibia (Poster). <i>Geological Society of Namibia 50th Anniversary Conference</i> , 1-4 Sep., Windhoek, Namibia, 95-96.
Spencer, C., Cavosie, A.J., Evans, N., Rankenburg, K. Thomas, R.J. and Macey, P.H. 2021. Granular titanite from the Roter Kamm crater in Namibia: Product of regional metamorphism, not meteorite impact. 52 nd Lunar and Planetary Science Conference, 15-19 Mar. (virtual).
Macey, P.H., Thomas, R.J., Kisters, A.F.M, Diener, J.F.A., Angombe, M., Doggart, S., Groenewald, C.A., Lambert C.W., Miller, J.A., Minnaar, H., Smith, H., Moen, H.F.G., Muvangua, E., Nguno, A., Shifotoka, G., Indongo, J., Frei D., Spencer, C., Le Roux, P., Armstrong, R.A., and Tinguely, C.. 2023. A continental back-arc setting for the Namaqua Belt: Evidence from the Kakamas Domain. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek Namibia, 92.
Muvangua, E., Indongo, J. and Mutongolume, C. 2023. Geology of the Aukam Valley, Namaqua Metamorphic Complex, Southwestern Namibia: Implications for Regional Tectonostratigraphy. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 95.
Shifotoka, G., Bailie, R. and Macey, P. 2023. The Lüderitz Domain of the Richtersveld Magmatic Arc, southern Namibia. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 98.
Indongo, J., Macey, P.H., Miller, J.A. and Shifotoka, G. 2023. The late-Namaqua Sperlingsputs Shear Zone System Haib region, southern Namibia. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 91.
Nguno, A., Macey, P. and Hoffmann, K.-H. 2023. Using major mapping programmes to develop capacity and drive research collaboration. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 96.
Pokolo, P. 2023. The need of Guidelines and Standardization in New Mapping Projects. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 97.
Sloan, R.A., Muir, R.A., Whitehead, B.A., Matsebula, A., New, T., Macey, P.H., Stevens, V., Groenewald, C., Salomon, G., Kahle, B., Hollingsworth, J. and Rieger, S. 2023. Mapping Neotectonic Fault Scarps in Southern Namibia. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 99.
Doggart, S., Harris, C. and Macey, P. 2023. Geochemical and isotopic zonation of the Orange River Pegmatite Belt in Southwestern Africa – links to magmatic-hydrothermal events during the late Stenian-Tonian Rodinian assembly of the Namaqua Metamorphic Province. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 87.
Doggart, S., Macey, P., Buick, I., Mayne, M., Smith, H., Lambert, C.W. and Groenewald, C. 2023. How geoscience mapping and research in the Orange River Pegmatite Belt provide valuable insights into critical metal mineralization within the pegmatites of the Namaqua-Natal Metamorphic Province. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 88.
Doggart, S., Thomas, R., Macey, P., Smith, H., Shifotoka, G., Groenewald, C., Twala, M. and Frei, D. 2023. The oldest rocks in Namibia: Archaean crustal fragments in the 1.9 Ga Richtersveld Magmatic Arc, NW Namaqua-Natal Metamorphic Province. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 89.
Groenewald, C.A., Lambert, C.W., Macey, P.H., Kisters, A.F.M., Angombe, M., Doggart, S., Smith, H., Rowe, C. and Indongo, J. 2023. The long-lived ductile to brittle evolution of the Marshall Rocks-Pofadder Shear Zone during the final stages of the 1.2-0.96 Ma Namaqua Orogeny, Namaqua Metamorphic Province, Namibia and South Africa. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 90.
Walter, B., Siegfried, P.R., Schiebel, D., Giebel, R.J., Doggart, S, Macey, P. and Kolb, J.. 2023. The Aukam Valley - a window into far-field, Jurassic age (?) fluorite and Cambrian age graphite mineralisation. <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 100.
Mutongolume, C. 2023. Geological mapping, petrological characterization and geochemistry of rocks in the Aus area southern Namibia: Implications for potential copper mineralization (Poster). <i>29th Colloquium of African Geology</i> , 26-29 Sept., Windhoek, Namibia, 94.

Musekiwa, C., Doggart, S., Cole, J., Janse van Rensburg, G., Phikiso, Z., Cole, P., Dudumashe, N., Sogayise, S., Macey, P. and Grobbelaar, D. 2023. Multispectral and hyperspectral remote sensing for geology mapping Namaqualand region, South Africa. *29th Colloquium of African Geology*, 26-29 Sept., Windhoek, Namibia, 93.

Appendix C. Post-graduate research projects completed during the SNMP (in chronological order)

Lambert (2013)	MSc	Stellenbosch University	Granitic melt transport and emplacement along transcurrent shear zones: Case study of the Pofadder Shear Zone in South Africa and Namibia
Smith (2013)	BSc Hons	Stellenbosch University	Mapping and Structural Characterisation of a Metamorphic Terrane near Warmbad, Southern Namibia
Skeate (2014)	BSc Hons	Stellenbosch University	Characterisation of the Provenance of the Velloorsdrif Schist (Grünau Terrane)
Gordon (2014)	BSc Hons	Stellenbosch University	Characterisation of F ₃ Fold Structures in the Grünau Terrane, Southern Namibia and Implications for Reworking of the D ₂ Namaquan Orogeny
Bate (2014)	BSc Hons	McGill University	Development of quantitative measures of seismically-induced brittle fracture
Melosh (2015)	PhD	McGill University	Earthquake cycling in the brittle-plastic transition of a transform boundary: The Pofadder Shear Zone, Namibia and South Africa
Sehloho (2015)	BSc Hons	Stellenbosch University	Petrography and Structure of the Ai-Ais Igneous Suite Host Rocks, Southern Namibia
Muller (2015)	BSc Hons	Stellenbosch University	Petrographic, Geochemical and Geochronological Analysis of the Ai-Ais Complex, Southern Namibia
Bishop (2015)	BSc Hons	University of Cape Town	A snapshot of the early Cambrian mantle: petrogenesis and geochemical investigation of the Grünau intrusives, Southern Namibia
Angombe (2016)	MSc	Stellenbosch University	The lithostratigraphy and structural components of the Eureka Shear Zone, southern Namibia
Indongo (2017)	MSc	Stellenbosch University	The Lithological and Structural Characterisation of the Sperlingputs Shear Zone in Southern Namibia
Doggart (2018)	MSc	Stellenbosch University	Geochronology and Isotopic Characterisation of LCT Pegmatites from the Orange River Pegmatite Province
Iiyambo (2019)	BSc Hons	University of Namibia	Chemostratigraphic correlation of a Diamictite-Cap Carbonate Succession in the Port Nolloth Zone, northern Sperrgebiet, Southern Namibia
Joseph (2019)	BSc Hons	University of Namibia	Geological Mapping, Petrographic and Geochemical Study of the Tschaukaib Granitic Suite in Comparison to the Komsberg Suite, South West Namibia
Togarepi (2019)	BSc. Hons	University of Namibia	Geological mapping, geochemistry and petrographic characterization of metapelites of the Garub Group rocks, South-East of Lüderitz
Vaino (2019)	BSc. Hons	University of Namibia	The geochemical and petrological characterization of the Lüderitz meta-gabbro (1.9 Ga) in comparison with the Vuurdood gabbro in the Richtersveld Magmatic Arc, South West Namibia
Niemandt (2020)	BSc Hons	Stellenbosch University	Igneous Petrology of the Gannakouriep Dyke Swarm and its Metamorphic and Structural Overprint by the Gariep Orogeny
Shifotoka (2023)	MSc	University of the Western Cape	The Lüderitz Domain, Namaqua Natal Metamorphic Belt