

NAMGROWS Namibian ground water systems

Euro African joint cave expedition

(A research project on karst aquifers in northern Namibia)

Alessio Fileccia¹

Abstract: During the last 20 years the discovery of some huge underground lakes has been reported worldwide. This presentation is about the results obtained from a set of expeditions aiming to study and document these karst areas, stressing the importance of cooperation between cavers and geologists of four different countries (Italy, Switzerland, Namibia, and South Africa). The project area is located in north Namibia (Otavi mountainland), also known as the “Caving triangle”. The first attempts carried out by the expeditions members, date back to the years 1986-87-88. Between 2005 and 2012 the biggest caves, both dry and submerged, have been surveyed. In Dragon’s Breath, having an extension of 180 m x 140 m, cave divers reached a depth of 105 m without touching the bottom or noting side passages, Aigamas lake is known to host the unique fauna of the blind fish *Clarias Cavernicola*, while Harasib Lake is located at the bottom of a deep 120 m shaft. The lake’s depth has been sounded down to 110 m. The surveys are part of a larger scientific study directed at a better evaluation of the ground water potential in semiarid regions through the installation of special recording instruments and preparation of piezometric maps.

Foreword

The project aims to describe and collect data on different topics of the underground environment in Otavi mountain land, such as:

- caves and underground lakes;
- groundwater potential;
- animal life.

Various people and experiences have been brought together: cavers, cave divers, geologists, biospeleologists and also local farmers and officials who helped us in different ways.

Several visits and contacts with the people between 2005 and 2012 allowed us to collect data that have been periodically published.

General framework

The northern part of Namibia is well known for the occurrence of wide areas of dolomitic rocks. Geologists have established that these formations are more than 500 million years old and made from the activity of submarine algae called stromatolites.

In this region located between 1300 and 1600 m asl many caves have been discovered, and some fully underwater. First explorations date back to the end of '80s but even 50 or 60 years ago local farmers tried to tap water, drilling the roof of these underground chambers.

The whole area is scarcely populated, less than one inhabitant per km² (1991 Population and Housing Census) and agriculture is dominated by cattle farming and crop production. Two important mines are located in Tsumeb and Kombat at the northern and southern boundaries. While being low, water abstraction for agriculture has already lowered the water table in some places and this has been worsened by mining activity.

The present project wishes to emphasize the importance of the underground environment, giving clues to its protection, from the cave to the aquifer potential and biological topics.



Figure 1: The research area (Otavi mountains)

¹ via Colonna 22, 31100 Treviso, Italy, geofile@libero.it

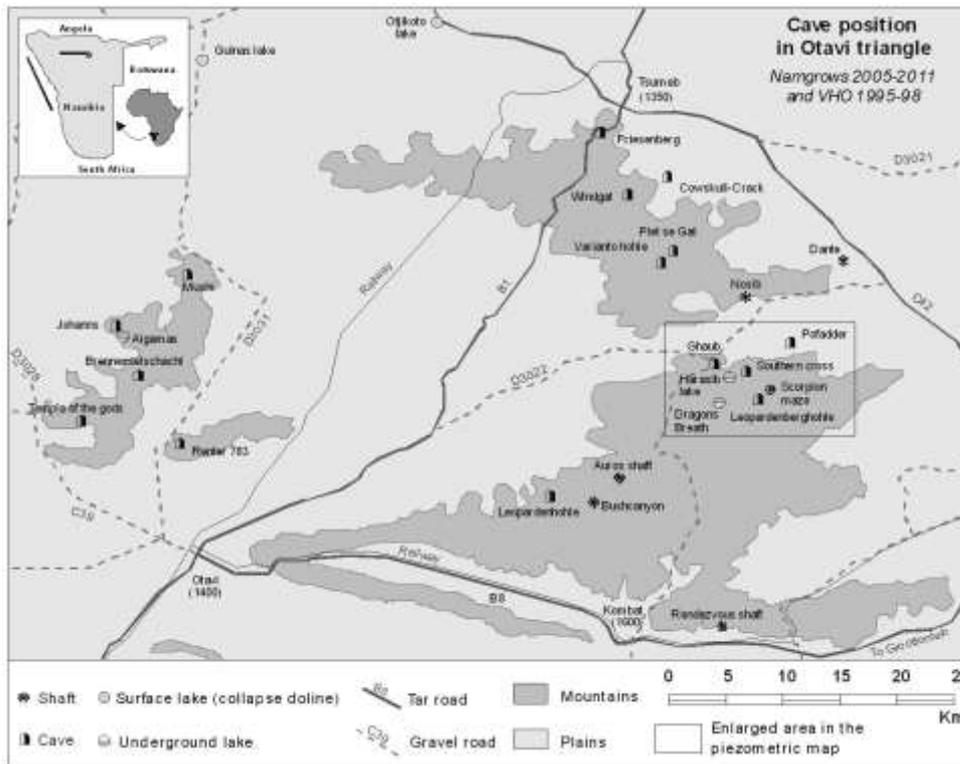


Figure 2: Research area. The area chosen is located between Tsumeb, Grootfontein and Otavi. Visits are also foreseen in Aikab (Etosha).

Former researches

During 1987 and 1988 we produced a video, worldwide distributed, and set up a deep exploration with the first discoverers of Dragon's Breath (Jacques Martini a Swiss geologist and the south African cavers of SASA). At that time we reached the lake bottom at 93 meters depth.

During 2005 and 2007 we explored new caves, analyzed deep water samples of Harasib lake and started cooperate with Dr Eugène Marais (Chief Curator of Museum of Natural History in Windhoek) and some local farmers (Mr. Jan and Gerhardt Engelbrecht, Mr Sarel Lacante and wife Leoni Pretorius). First analysis revealed that these deep waters at 100 m below lake's surface, are relative young (60 years) suggesting a high vulnerability and a rapid renewal of the resources.

In 2010-2011 missions, the project expanded into the following directions:

- Cave survey and exploration;
- Hydrogeological researches;
- Filming.

Caves

Dragon's Breath Lake has been the main target with a complete survey of the dry passages and underwater diving by means of rebreathers, reaching a depth of 105 m, but not the bottom of the cave. Some dives have also been done into Aigamas cave, where we started a new survey and documented the habitat of the blind fish *Clarias cavernicola*.

We also have organized the maps of several caves in the region, in anticipation of the creation of a national cave register.

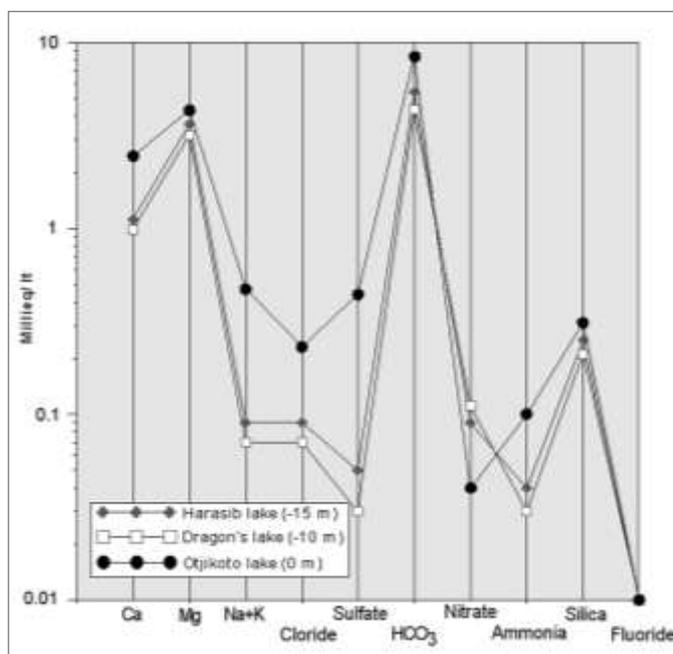


Figure 3: Water analysis for three karst lakes in Otavi region. A fairly good agreement between Harasib Lake and Dragon's Breath is clearly marked (2005-07)

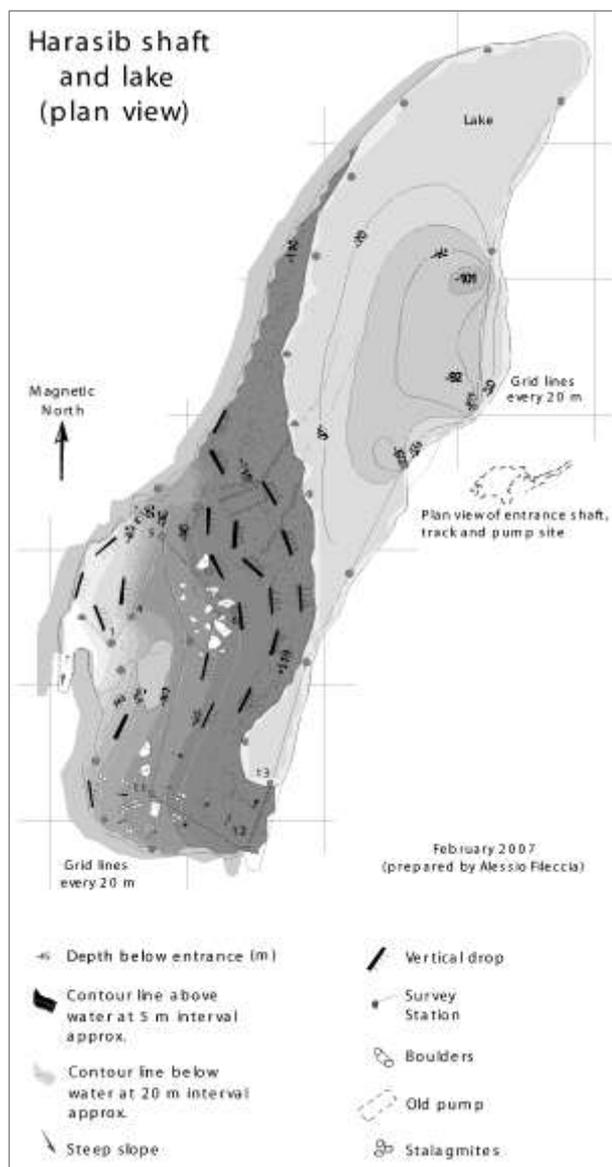


Figure 4: Survey of Harasib shaft, plan view

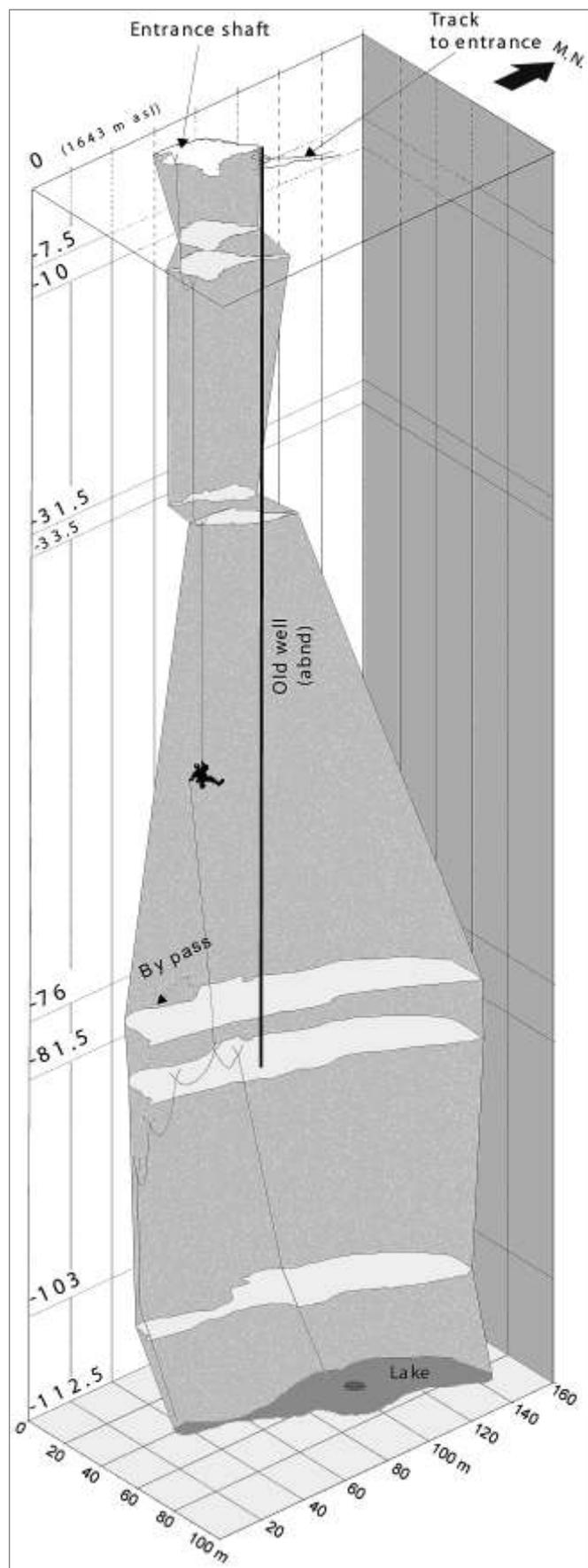


Figure 5: 3D-view, right: two old casing wells are still in the shaft. When they were drilled the water level was some 30 meters higher, but abstraction and scarce precipitation lowered the water, so they were later abandoned.



Figure 6: The underground chamber of Dragon's Breath, located 70 m underground. The lake is more than 100 m deep. (Namgrows 2011).

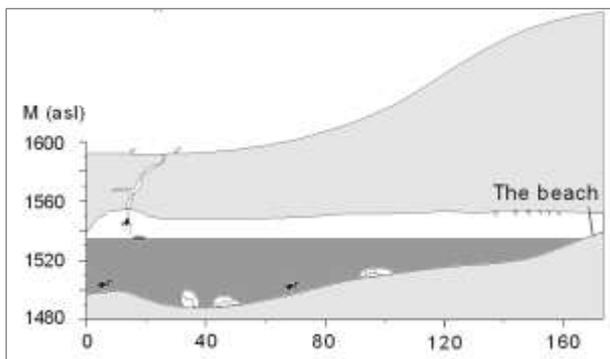


Figure 7: Simplified profile of Dragon's Breath, along main axe of chamber's lake (Namgrows 2011).

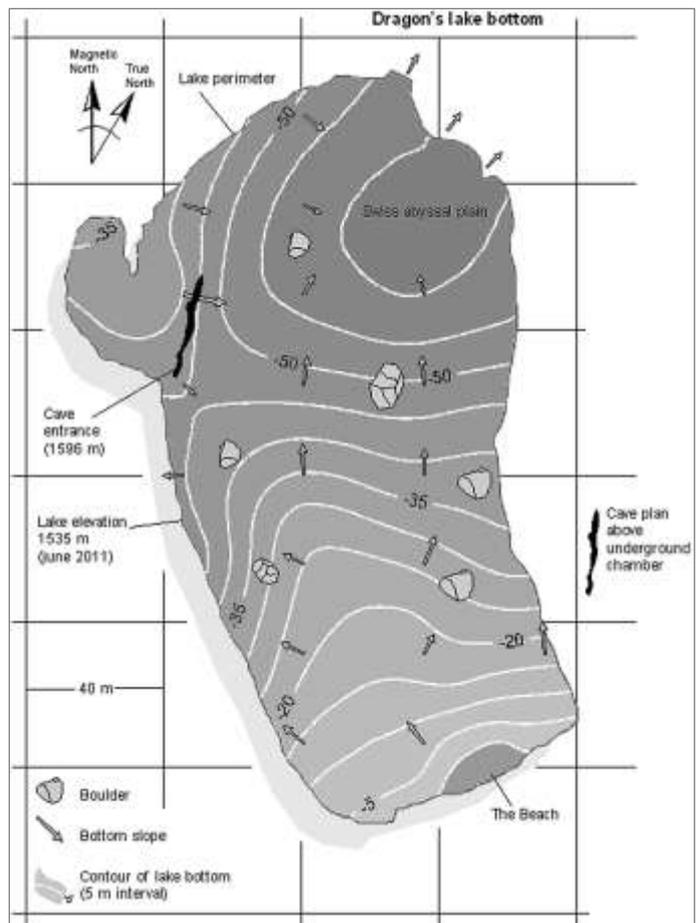


Figure 8: Plan view of the lake's surface with bottom contour lines (June 2011).

Hydrogeological researches

In February 2007, September 2010 and June 2011 we prepared two hydrogeological maps at 1:50000 scale of Harasib and Hoba farms and plan to prepare a more detailed one using new borehole and information on a wider region. Furthermore four level loggers have been lowered in two lakes and one well, to monitor the water table during 10 months at 1 hour interval. The maps

allowed us to reconstruct the main underground water flows, recharge and discharge areas and water table depth, giving also additional clues to the hydraulic connection between the two lakes of Harasib and Dragon's Breath which are only 2.5 km apart. The data from the transducers have provided valuable insights into the aquifer properties and flow connections, highlighting also the influence of earth tides.

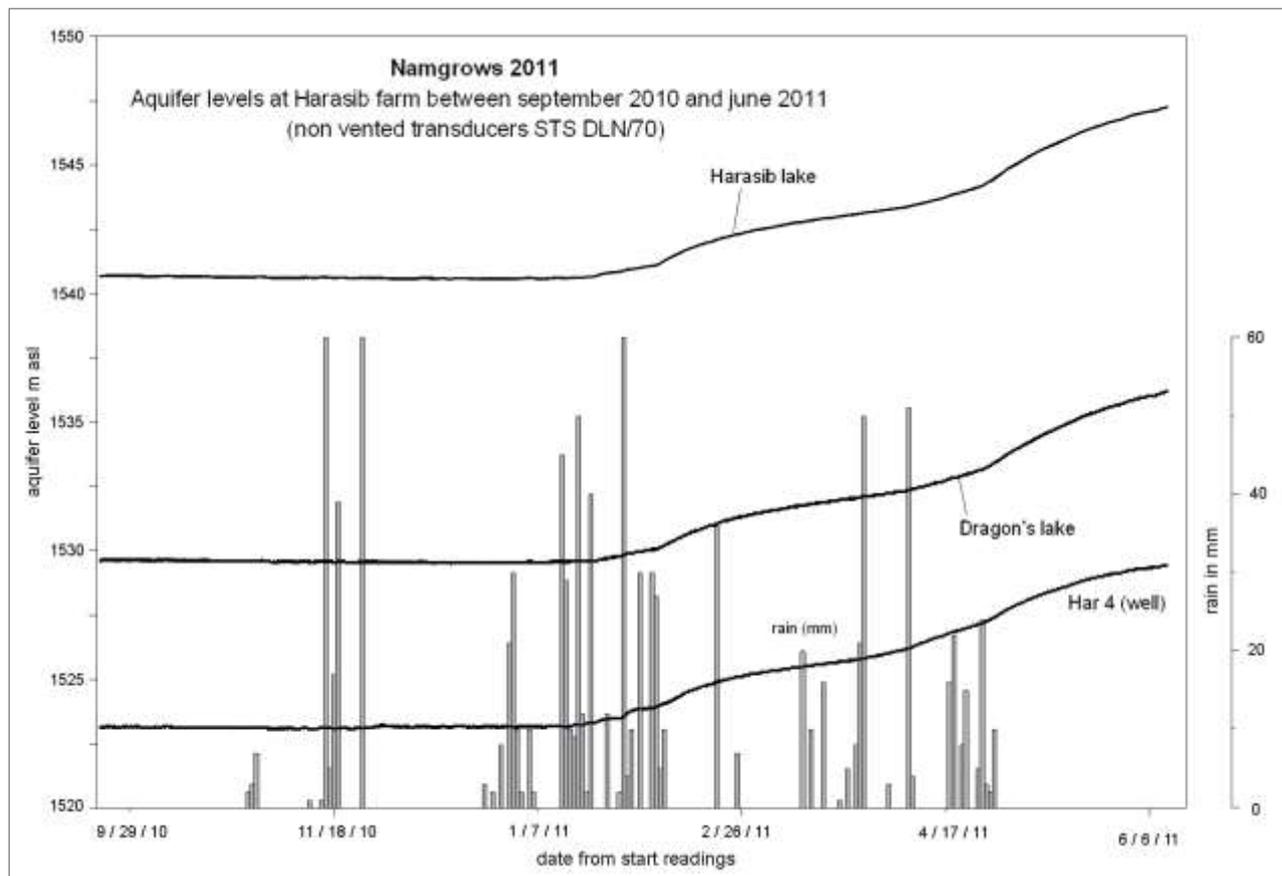


Figure 9: All data gathered during the monitoring interval at hourly readings (except for the barometric pressure). The three black curves show a rising in water level of 5-7 m. in two lakes and one well. During the time interval, rain was particularly abundant for the season, with more than 1000 mm. The rain gauge was installed at the Harasib farm, 1-2 km far from the loggers. The aquifer recharge starts when cumulative rain exceeds 400-500 mm. The thickness of the unsaturated part ranges from 40 to 100 m.

Filming

All project stages have been videotaped to document the environment, the caving equipment and exploration techniques but also to show how a fruitful collaboration among cavers, geologists and local agencies can improve the knowledge of the environment and the management of ground water.

To this we performed several interviews to officers and farmers to explain the local use of ground water in Namibia and conservation politics. In June 2012 further shooting is foreseen to document the relationships between mine activity and aquifers

Further information and long term benefits of the study

An interesting topic is the local use and abstraction of ground water. The main sectors are mining, agriculture and municipalities and based on a recent report of the Ministry of Agriculture, the total abstraction for the Tsumeb, Otavi and Grootfontein aquifers is more than 33 Mm³/yr, of which one third for irrigation purposes.

Since the '20s the local farmers have noticed the link between caves and groundwater and even now one of the main point of abstraction for irrigation purpose, in the SE part of the so called Otavi triangle, is Dragon's Breath (the huge underground lake of 2.6 ha of extension).

A drop in the water level (as deep as 30 m) is taking place since the end of '70s due both to natural and artificial phenomena.

On the wall of Harasib shaft is still visible a mark and the name the first explorers left in 1957, most likely drawn from a small boat. The sign is now 30 m above the lake surface. During the last 3-4 years a slight increase in the recharge has been recorded due to precipitation, but the value is still low (< 5%, MAWRD 2004) and in some places the lowering of the water table is clearly related to well abstraction.

During our visits in 2005 and 2007 we carried out several water level measurements and noticed that many wells have a low production and become dry after a short period of pumping.

In the end the karst aquifer management should take into consideration a careful approach to preserve it in the future, like:

- The reuse of water from the mining sector;
- The development of artificial recharge techniques;
- Reducing the impact of chemical components (fertilizers) infiltrating into the aquifer;
- Delineating the depth of karst erosion and hydraulic connection.

The future

In summer 2012 plans are the following:

- Complete the filming in the caves and underground lakes, with more interviews to local officers;

- Explore, survey and filming into Aigamas and Aikab lakes;
- Strengthen the collaboration with local agencies for a fruitful exchange of data and information regarding the aquifer assessment, its protection and the setting up of a national cave register.

Participants, sponsors, support

Société Spéléologique Genevoise (Genève, Switzerland);

G.S. Arianna, G.S.; CAI Vittorio V., Treviso, Italy;

STS manufacturer of monitoring equipment; the Italian branch has given us as a loan, 5 level loggers that recorded ground water levels during 10 months (www.sts-italia.it);

Sarel Lacante, South African engineer, owner of the farm Harasib with his wife Leoni Pretorius helped us for lodging, transportation and general logistics;

Andre Kompion of Ghaub farm;

Axel and Silke Bauer of Aigamas farm.

Organization

Gérald Favre, Switzerland (geologos@bluewin.ch), hydrogeologist, caver and film producer since '80s, working on many scientific documentaries of the underground world in Iceland, Hawaii, Papua New Guinea.

Alessio Fileccia, Italy (www.filecciageologia.it), hydrogeologist and caver, has worked on the ground water sector in several African countries, setting up various research projects on karst topics.

Berclaz Vincent
Bouffartigue Nathalie
De Mori Michele
Favaro Andrea
Favre Gérald
Favre Robin
Fileccia Alessio
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Marti Philippe
Martinez Johnny
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