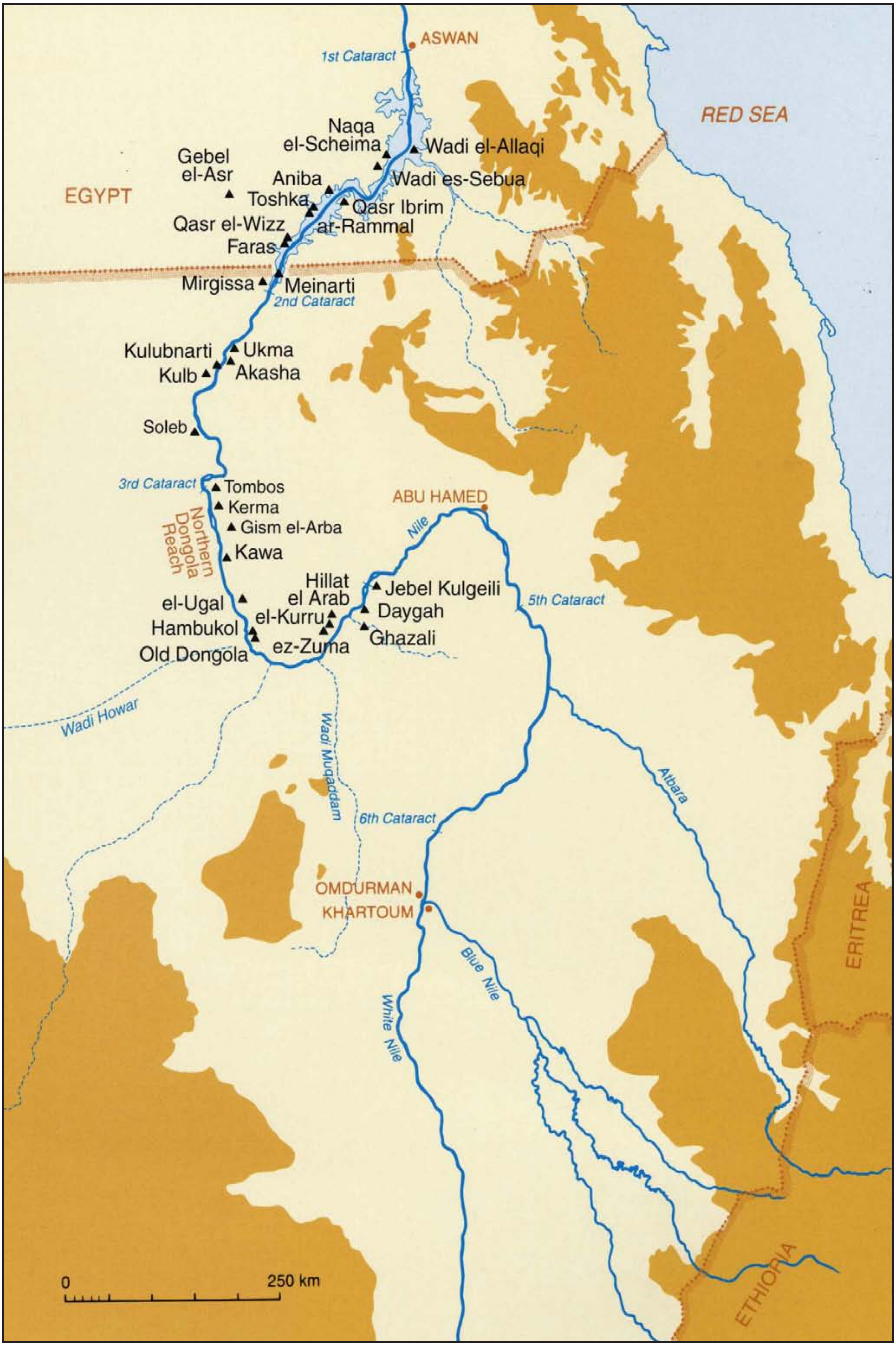
SUDAN & NUBIA

The Sudan Archaeological Research Society Bulletin No. 3 1999


ASWAN
1st Cataract
RED SEA
Naqa
el-Scheima
Wadi el-Allaqi
Gebel
el-Asr
Aniba
Wadi es-Sebua
EGYPT
Toshka
Qasr Ibrim
Qasr el-Wizz
ar-Rammal
Faras
Mirgissa
Meinarti
2nd Cataract
Kulubnarti
Ukma
Kulb
Akasha
Soleb
3rd Cataract
Tombos
Kerma
Gism el-Arba
Northern
Dongola
Reach
Kawa
ABU HAMED
Nile
Hillat
el Arab
Jebel Kulgeili
el-Ugal
el-Kurru
Daygah
5th Cataract
Hambukol
Ghazali
ez-Zuma
Old Dongola
Wadi Howar
Wadi Muqaddam
Atbara
6th Cataract
OMDURMAN
KHARTOUM
ERITREA
Blue Nile
White Nile
ETHIOPIA
0
250 km

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Contents

Front Cover: Temple of Amenophis III at Soleb visited by F. W. Green in 1909 (Photo D. A. Welsby).

Introduction

As the contents of this year's issue clearly demonstrate, *Sudan & Nubia* goes from strength to strength with a developing international profile. The Society's own work in the Dongola Reach is represented by two papers; the first, based on the analysis of human remains, provides fascinating insights into living conditions during the Kerma Period (Judd); the second outlines progress on the continuing research into the geomorphology of the region (Treves *et al.*). A complimentary project, carried out in the same region by a French Expedition, has among other things identified a rare native settlement dating to the period of Egyptian conquest (reported on by Gratien). At Kerma itself, exciting new work, uncovering remains of the Napatan and Meroitic Periods, is dramatically extending the history of the site (Salah Ahmed), while of equal importance historically are the results from Hillat el-Arab (near Gebel Barkal), a cemetery with elite burials of the New Kingdom and very earliest Kushite Period (Vincentelli). Research into quarrying and stones receives fresh impetus from work at Gebel El-Asr in Lower Nubia (Shaw and Bloxam) and in Tombos and Daygah at the Third and Fourth Cataracts respectively (Harrell). Surveys in the latter region, threatened by a new dam, are confirming its great archaeological potential (Abdel Rahman and Kabashy Hussein). Among other possibilities, sites in the Abu Hamed Reach can be expected to shed important new light on Nubian monasticism, until recently a neglected subject (Julie Anderson). Further north, Qasr Ibrim, which has long been partially submerged, continues to repay the Egypt Exploration Society's commitment under difficult circumstances (John Alexander). Far from the Nile Valley, museum basements can also be a source of significant 'discoveries' (Wardley and Davies), as may unpublished archival material and archaeological diaries (Welsby Sjöström).

During the course of the year, SARS suffered a serious blow with the passing of its distinguished President, Sir Lawrence Kirwan. Larry was a source of encouragement, support and inspiration for us all. We salute his memory and his contribution to Sudanese and Nubian archaeology (see Obituary, by Harry Smith). We also regret the loss of Prof. Jack Plumley, a specialist in Christian Nubia, who for many years directed the EES excavations at Qasr Ibrim (see Obituary, by John Alexander).

Remote Sensing of Palaeo-channels in the Northern Dongola Reach of the Nile

Richard Treves, Mark Macklin and Jamie Woodward

Introduction

Our previous reports have focussed on the stratigraphy and sedimentology of the alluvial sediments in the Northern Dongola Reach and the application of luminescence dating techniques to establish a chronology of river behaviour during the Holocene Period (Macklin and Woodward, 1997; 1998). This paper outlines recent progress on our investigations of the geomorphology of the Northern Dongola Reach using data acquired by satellite remote sensing. Preliminary analyses of the satellite imagery are described and the potential for the application of Geographical Information Systems (GIS) to investigate the relationship between the archaeological survey data and the palaeochannel belts is outlined.

Satellite Remote Sensing

Two types of satellite imagery have been acquired for the Northern Dongola Reach, a multispectral image from the French SPOT (Systeme Probatoire de l'observation de la Terre) sensor and a Synthetic Aperture Radar (SAR) image from NASA. The main characteristics of these types of imagery are shown in Table 1.

Imagery	Pixel Size	Image Size	Bands 1	Bands 2	Bands 3	Active/Passive
SPOT	20m	64 x 60 km	Green	Red	Near Infrared	Passive
SAR	100m *	57 x 107 km	L-Band	C-Band		Active

** This should reduce with further processing*

Table 1: Characteristics of the imagery employed in this study

Using data supplied with the image from the satellite sensor, the SPOT image has been georeferenced so that a point on the image can be accurately related to a point on the ground. As yet, the SAR data cannot be georeferenced in this manner and this imagery has been provisionally georeferenced (using ground control points) to the SPOT image. This process involved finding clearly distinguishable features on both images such as roads, palaeochannels and large bedrock outcrops. By using image processing software, the radar image is 'rubber sheet stretched' so that the points coincide. During the next field season we will compile a network of reference points using a Global Positioning System (GPS) based on distinctive features across the survey area that are identifiable on the SPOT image. These ground control points will allow further refinement of the georeferencing procedure for both of the images. This is an important step to facilitate valid comparisons between the various geomorphological features and the archaeological data.

The SPOT imagery shown in Colour Plate III clearly shows the positions of major palaeochannel belts and palaeoconfluences (Box B) in the Northern Dongola Reach and the modern agricultural development associated with them to the east of the modern Nile. The channel features appear as dark coloured low sinuosity forms with bright red pixels representing the irrigated areas. The sharp boundary with the bedrock plateau to the east of the survey area is also clearly visible and part of this is highlighted in Box C. Other large-scale landscape features identifiable from the SPOT image include the extensive dune fields such as the one shown in Box A and the extensive Seleim Basin in the north of the image to the east of the present Nile. The SAR imagery is a potentially valuable means of establishing the spatial extent and form of the palaeochannels as it shows high reflectance primarily where the surface substrate has a high water content. In contrast to the SPOT imagery, SAR records surface *and* subsurface information and with further processing will be helpful in the recognition of buried geomorphological features within the reach. Colour Plate IV shows part of the SAR image with the modern Nile to the left and the palaeochannel belts, shown as bright lines, to the east of the Nile.

Preliminary processing of the SPOT image has allowed the identification of the palaeochannel belts in the reach and their broad relationship to other major geomorphological features such as the low angle alluvial fans which drain westwards from the bedrock plateau in the east of the survey area. Using a combination of digital image processing methods and visual interpretation, the SPOT image will be classified to produce a map of the main geomorphological features in the Northern Dongola Reach. Furthermore, by comparing the SPOT and SAR imagery the different characteristics of the two images can be exploited to establish the nature and extent of the palaeochannel belts and their relationship to the pattern of Kerma and earlier settlement.

GIS

Archaeological Data and SPOT imagery

All the archaeological sites identified during the Northern Dongola Reach Survey are spatially referenced by GPS and this allows their relationship to the geomorphological features to be investigated at a range of scales. The archaeological survey data include sites from several periods and all of these have been imported into a GIS. This has been merged with the SPOT image so that the archaeological sites can be viewed in their geomorphological context shown on the satellite image (Colour Plate V). The broad relationship between the archaeological sites and the palaeochannels had been discussed by Welsby (1997) and an example is shown in Box C of Colour Plate V. In general the Kerma Period sites display a close relationship with the palaeochannels. However, it is interesting to note that some palaeochannels have no clear association with archaeological sites (Box A). Some of these palaeochannels may pre- or post-date the Kerma Period and this could explain the absence of archaeological sites around them. In any case, this GIS-based approach can be used to identify palaeochannel forms which would merit further field investigation and luminescence dating (cf. Macklin and Woodward 1998). Some of the archaeological survey data were collected along east-west transects (cf. Welsby 1995) and these can be seen as distinctive lines across parts of the image (Box B). The survey method has implications for statistical analysis of the settlement patterns, so these data will be examined for any bias that may be related to the data collection process.

Detailed analysis of the pottery collected from the survey and excavation work will allow the site distribution data to be stratified further into different cultural periods. These data will also be viewed within a GIS to explore the relationship between settlement patterns, site function and geomorphological context for different periods of time. Moreover, this approach may help to refine our chronology for the age of different parts of the palaeochannel belts. It may also allow for statistical analysis of the spatial distribution of archaeological sites and geomorphological features.

Future work: Ground Penetrating Radar (GPR)

During the next field season a GPR system will be used to study the stratigraphy of the palaeochannel belts and a selection of archaeological sites in the reach. The use of GPR in this environment should provide good quality high resolution data since it performs best in areas of extreme aridity (Conyers and Goodman 1997). GPR is also a very useful tool to use in combination with the SAR data since - in broad terms - both approaches measure changes in the same physical characteristic. For example, an area with a high SAR reflectance relative to the surrounding area could indicate a buried channel that is not visible on the SPOT image and would merit field-based, high resolution investigation with the Ground Penetrating Radar.

Conclusion

Our preliminary work on satellite remote sensing and GIS has demonstrated the considerable potential of this approach and during the next field season the use of high resolution GPR within our continuing programme of geomorphological and stratigraphical field research will yield further insights into the relationship between archaeology and geomorphology in the Northern Dongola Reach.

Acknowledgements

We are grateful to Derek Welsby for supplying the site distribution data and for help with image interpretation.

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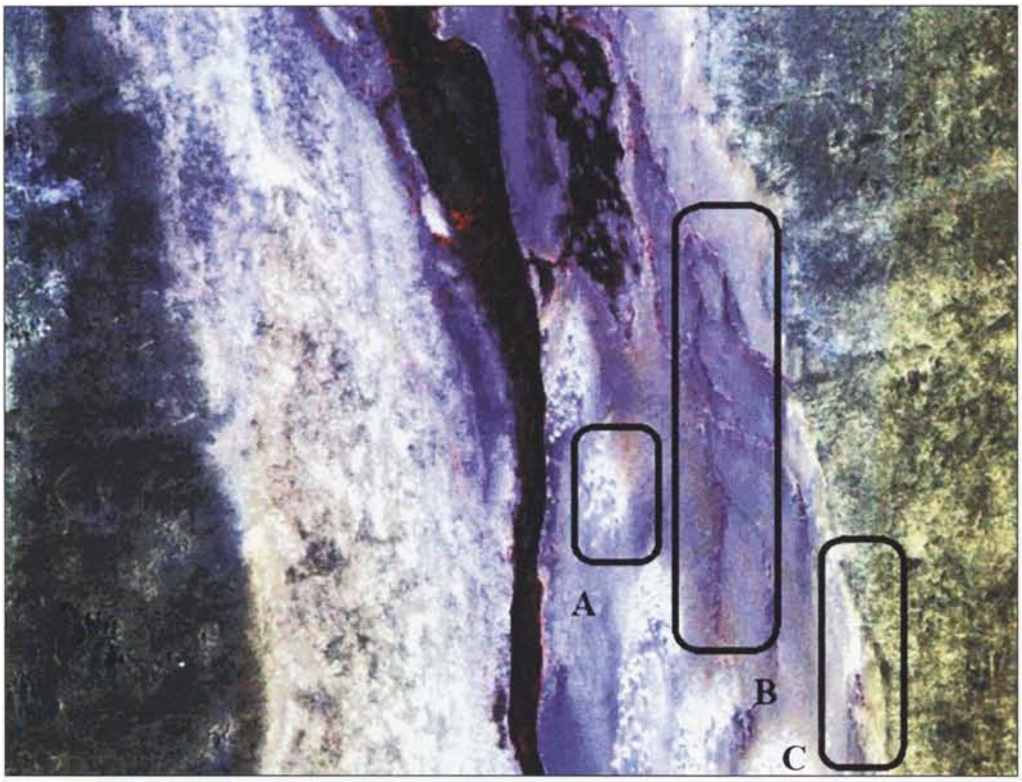

Plate III. A false colour composite SPOT image of part of the Northern Dongola Reach showing the major geomorphological features in the area. See text for discussion of features in boxes. This image covers an area of approximately 50 x 40km.

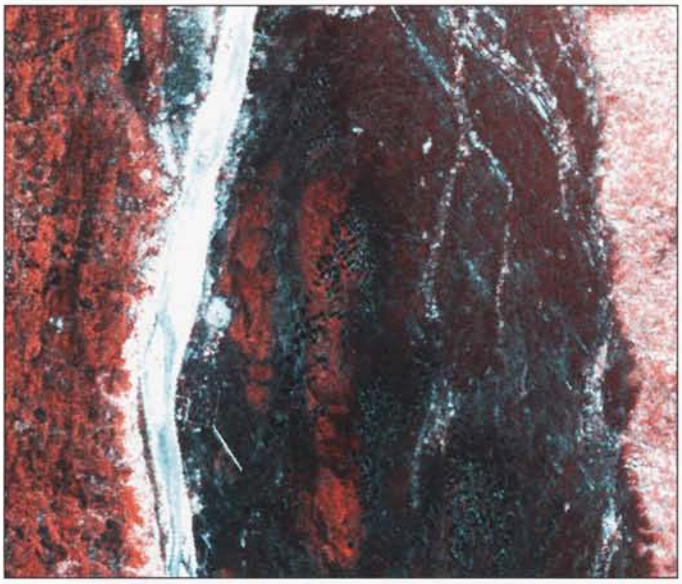

Plate IV. SAR image of part of the Northern Dongola Reach. This image covers an area of approximately 20 x 25km.

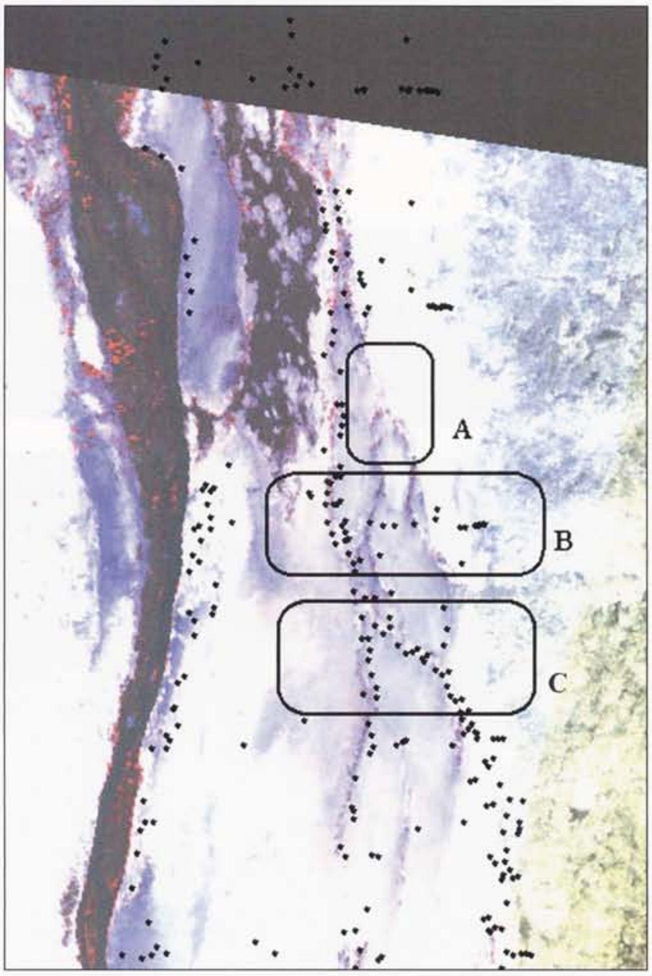

Plate V. SPOT image of part of the Northern Dongola Reach showing the sites identified by the archaeological survey. See text for discussion of features in boxes. This image covers an area of approximately 35 x 30km.