Mar Geophys Res (2010) 31:285–298
DOI 10.1007/s11001-010-9110-0

ORIGINAL RESEARCH PAPER

Bathymetry enhancement by altimetry-derived gravity anomalies in the East Sea (Sea of Japan)

Kwang Bae Kim · Yu-Shen Hsiao · Jeong Woo Kim · Bang Yong Lee · Yi Kyun Kwon · Chang Hwan Kim

Received: 10 February 2010 / Accepted: 18 November 2010 / Published online: 4 December 2010

Abstract The gravity-geologic method (GGM) was used to enhance the bathymetry of the East Sea (Sea of Japan) with satellite altimetry-derived free-air gravity anomalies and shipborne depth measurements. By comparison with the bathymetry model of Smith and Sandwell's (SAS) approach (1994), GGM was found to have an advantage with short wavelength ($\leq$12 km) components, while SAS better predicts longer wavelength ($\geq$25 km) components, despite its dependency on density contrast. To mitigate this limitation, a tuning density contrast of 10.25 g/cm^3 between seawater and the seafloor was primarily estimated by the downward continuation method and then validated by the check points method with GGM. Similarly, SAS is limited by the "*A*" value in low-pass part of the Wiener filter, which defines the effective range of the wavelength components on bathymetry. As a final result, we present an enhanced GGM bathymetry model by integrating all available data.

K. B. Kim · Y.-S. Hsiao · J. W. Kim (✉)
Department of Geomatics Engineering, University of Calgary, 2500 University Drive NW, Calgary, AB T2N 1N4, Canada
e-mail: jw.kim@ucalgary.ca

Y.-S. Hsiao
Department of Civil Engineering, National Chiao Tung University, Hsinchu, Taiwan, ROC

B. Y. Lee
Korea Polar Research Institute, Incheon 406-840, Korea

Y. K. Kwon
Korea Institute of Geoscience and Mineral Resources, Daejeon, 305-350, Korea

C. H. Kim
East Sea Research Institute, Korea Ocean Research and Development Institute, Uljin 767-813, Korea

Keywords Bathymetry enhancement · Altimetry-derived free-air gravity anomalies · East Sea (Sea of Japan) · Gravity-geologic method (GGM) · Density contrast

Introduction

Seafloor topography, or bathymetry, has traditionally been mapped by shipborne echo sounding measurements that are time-consuming and, because of the limited and uneven distribution of the measurements, often biased. However, the advent of the satellite radar altimeter has made it possible to estimate global bathymetry more economically and accurately. Since the late 1970 s, several satellite radar altimeters, such as Seasat (Born et al. 1979), Geosat (Cheney et al. 1986), ERS-1 and 2 (Gottschalk 1991; Francis et al. 1995), and TOPEX/Poseidon (Fu et al. 1994) have provided dense sea surface topography by measuring the distance between the satellite and the sea surface.

These measurements can be converted to geoid, free-air gravity anomalies (FAGA) and bathymetry. Since the variations of FAGA are theoretically correlated with undulations of crustal density variations of the local bedrock beneath the ocean floor, dense FAGA data that have been derived from satellite radar altimeter measurements can be used to predict bathymetry with the assumption that there is no horizontal density variation. Because of this limitation, shipborne bathymetry is required as a constraint.

Several methodologies for recovering bathymetry have been studied in recent decades. Dixon et al. (1983) compared the predicted bathymetry by one-dimensional filtering of the geoid heights obtained from tracks of the Seasat satellite altimeter (Born et al. 1979) with observed

Journal of Coastal Research	SI 64	1764 - 1768	ICS2011 (Proceedings)	Poland	ISSN 0749-0208

Applying an Underwater Photography Technique to Nearshore Benthic Mapping: A Case Study in a Rocky Shore Environment

J.-Y. Park† J. Y. Choi‡ and E. Y. Jeong†

†East-Sea Research Institute
Korea Ocean Research & Development Institute
Uljin, 767-813, Korea
jypark@kordi.re.kr
eyjeong@kordi.re.kr

‡Dept. of Oceanography
Kunsan National University
Kunsan, 573-701, Korea
jinyong@kunsan.ac.kr

ABSTRACT

Park, J.-Y.; Choi, J.Y.; and Jeong, E.Y., 2011. Applying an underwater photography technique to nearshore benthic mapping: A case study in a rocky shore environment. Journal of Coastal Research, SI 64 (Proceedings of the 11th International Coastal Symposium), 1764 – 1768. Szczecin, Poland, ISSN 0749-0208

Underwater photography technique was examined to apply digital raster images to nearshore benthic mapping of Dokdo, which is located farthest east from mainland of South Korea. Seabed underwater-photography survey was conducted for three survey lines at the nearshore zone. A total of 315 quasi-orthogonal color JPEG photographs of the seabed were taken sequentially along the survey lines by using an underwater digital camera system. The digital photographs were post-processed for adjusting the color, brightness and geometry of them using digital image processing software. The post-processed sequential photographs of each survey line were stitched as single image mosaics using a photo stitching software. The resulted image mosaics of Lines 1, 2 and D have 2191 x 48482 pixels (~7.5 m x 168 m), 2717 x 43097 pixels (~9.3 m x 148 m) and 4461 x 29720 pixels (~15.2 x 80 m) in image size (image area), respectively. The image mosaics visually show transitional changes and boundaries of geological features thanks to their panoramic areal coverage. Their high image resolution also allows us to easily identify and classify the sedimentary characteristics and sand bedform features as well as certain benthic organisms. As a final process, we added georeference information to the image mosaics to make a 3-D photo surface bathymetry map and put them into a GIS system.

ADDITIONAL INDEX WORDS: *Geomorphology, image mosaic, georectification, GIS, Dokdo.*

INTRODUCTION

Benthic habitat mapping, which is an integration of biological, geological and physical data, is a fundamental step for managing and preserving coastal zones as well as examining unknown coastal environments. Among the integrated data in the benthic map, surficial geologic data of the morphology and sediment type are essential information because there is a strong correlation between the spatial distribution of different marine organisms and particular surficial geologic characteristics and morphologic features, especially, in rocky shore environments (Barrie and Conway, 2008). Rocky nearshore environment usually has more diverse geological and biological characteristics compared to sandy nearshore environment. Its irregular bathymetric feature, however, results in harsh conditions on accessibility for benthic mappings and sampling surveys.

Dokdo is located farthest east from mainland of South Korea (about 216.8 km) and consists of two main volcanic islets with very steep slopes, called as Dongdo (Eastern Island) and Seodo (Western Island), and 89 small volcanic islets (Figure 1). The nearshore zone between two islets is a semi-closed shallow water environment with a range of 0 m to 15 m in water depth. Due do exposed rock basements and volcanic rocks of various sizes on the nearshore bottom, its bathymetric pattern is irregular, especially, close to the shores of two islets (Figure 1-A). Distance between the two islets is variable with a range of 120 m to 200 m with an average water depth of about 5.4 m (Line 1 in Figure 1-B). Water depth at the southern nearshore zone decreases as going to the north (Figure 1-B). Because of its geographical location and high wave energy condition, however, few scientific researches have been conducted to examine the nearshore environment of the islet.

Since 2009, as a scientific research challenge and a part of coastal-zone survey technique development, the Korea Ocean Research & Development Institute (KORDI) has been conducting a multidisciplinary research project for nearshore benthic habitat mapping of Dokdo. As its first survey site, we selected the southern nearshore zone between Dongdo and Seodo and have been conducting geological and biological surveys.

For identification of nearshore geologic feature and morphology of the islet we conducted an underwater photography survey using an underwater digital camera system for acquiring high-resolution seabed images in addition to a nearshore bathymetry survey using a multibeam echo sounder.

In this paper we describe an underwater photography technique used for making panoramic image mosaics of the surveyed nearshore seabed and show preliminary results of georectified image mosaics with bathymetry information.

METHODS

The underwater photography survey was conducted for three survey lines of the site for two days from January 17th, 2010 to January 18th, 2010. Lines 1 and 2 are 168 m and 148 m in distance crossing from Dongdo to Seodo, respectively and Line D is 80 m in distance along the dockside located at the west side of Dongdo (Figure 1).

ToxEHS

Changes in Gene Expression in the Brown Alga *Undaria pinnatifida* (Harvey) Suringar (Laminariales, Pheophyceae) between Natural Populations

Seonock Woo[1], **Young Wook Ko**[2], **Jeong Ha Kim**[2] **& Seungshic Yum**[1]

[1]South Sea Environment Research Department, Korea Ocean Research and Development Institute, Geoje 656-830, Korea
[2]Department of Biological Science, Sungkyunkwan University, Suwon 440-746, Korea
Correspondence and requests for materials should be addressed to S. Yum (syum@kordi.re.kr)

Accepted 4 April 2011 DOI 10.1007/s13530-011-0083-4

Abstract

Genes involved in defense mechanisms can be used as efficient biomarkers of physiological changes in organisms caused by both endogenous and exogenous stress. Thus, the expression levels of such genes serve as a critical 'early warning system' for the environmental assessment and health of biological organisms. In this study, the transcription levels of *Hsp70* and *vBPO* in *Undaria pinnatifida* sporophytes were quantitatively compared between two distinct natural populations collected from uncontaminated Mijo (Namhae, Korea) and industrially-polluted Myodo Is. (Yeosu, Korea) in order to verify their potential as biomarker genes and the applicability of this macroalga for assessing the health status of a local marine ecosystem. The results found that the two tested genes were highly expressed in the Myodo population. The results suggest that *U. pinnatifida* itself and the selected two genes could be applicable to monitoring of marine environments in coastal regions.

Keywords: *Undaria pinnatifida*, Brown alga, Differential gene expression, *UpiHsp70*, *UpivBPO*, Real-time quantitative PCR

Introduction

Coastal areas play a number of important environmental roles, including transfer of matter, energy, and living organisms between terrestrial and marine ecosystems. These regions contain critical habitats rich in biodiversity with high biological productivity. Such benefits promote increases in the coastal population, however, which produces sewage and industrial and/or agricultural effluents that worsen the coastal ecosystem itself. Anthropogenic pollutants act as stressors to biological organisms and induce metabolic changes, which are regulated by molecular signals related to self-defense mechanisms, such as immune, antioxidant, and detoxification systems. The molecular information involved in such mechanisms can be used as molecular biomarkers, which are defined as the change in a biological process in response to toxic exposure or to toxic effects caused by environmental changes[1,2].

Marine macroalgae, commonly known as seaweeds, are very important components of marine ecosystems and are valuable sources of food, biochemicals, and pharmaceuticals. They assist in supplying oxygen and are one the primary producers in the marine food web. They also assist in the structuring of aquatic ecosystems by offering a fertile habitat to many aquatic organisms. Seaweeds are probably one of the sentinel species in coastal environments since most of them are sessile, directly contact water mass, and inhabit coastal regions where land-based pollutants finally accumulate.

Undaria pinnatifida (Harvey) Suringar (Figure 1) (Miyok in Korean) shows global distribution, including in North-east Asia, Europe, North to South America, Australia, and New Zealand (Algaebase http://www.algaebase.org), and it inhabits intertidal to sublittoral zones in rocky shores. For these reasons, this species is worthy of investigation as a sentinel species for environmental changes. This species is particularly important as a food source in Korea, Japan, and China. Moreover, fucoidan, a sulfated polysaccharide isolated from this species shows various biological activities such as inhibition of *Herpes* virus reactivation[3], antitumor effects[4], and defensive effects against virus infection[5]. Another biochemical substance, polyunsaturated fatty acids, isolated from this species also shows anti-inflammatory activities[6]. Recently, we isolated *U. pinnatifida* homologues genes related to natural and anthropogenic stress responses and successfully