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Lacustrine flow (divers, side scan sonar, hydrogeology, water penetrating radar) used to understand the location of a drowned person

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SUMMARY

An unusual application of hydrological understanding to a police search is described. The lacustrine search for a missing person provided reports of bottom-water currents in the lake and contradictory indications from cadaver dogs. A hydrological model of the area was developed using pre-existing information from side scan sonar, a desktop hydrogeological study and deployment of water penetrating radar (WPR). These provided a hydrological theory for the initial search involving subaqueous groundwater flow, focused on an area of bedrock surrounded by sediment, on the lake floor. The work shows the value a hydrological explanation has to a police search operation (equally to search and rescue). With hindsight, the desktop study should have preceded the search, allowing better understanding of water conditions. The ultimate reason for lacustrine flow in this location is still not proven, but the hydrological model explained the problems encountered in the initial search.

1. Introduction

This work aims to demonstrate how hydrologists (hydrogeologists, limnologists included) can assist in understanding the results of a police search that could be useful in other searches (by the police or search and rescue personnel) where understanding water conditions is required, be they like this case, or generally. The location of objects submerged in water is commonly undertaken by search and rescue, law enforcement, environmental, and engineering personnel (McGrane et al., 2013; Schultz et al., 2013). Visual inspection by divers is often augmented by use of search dogs, side scan sonar and geophysics (high resolution seismic [CHIRP], ground penetrating or water penetrating radar [WPR] and magnetometers, (Schultz et al., 2013; Parker et al., 2010). The conjunctive use of two or more search assets is mentioned in textbooks on canine behaviour (Rebmann and Sorg, 2000; Snovack, 2004) and drowning victims (Armstrong and Erskine, 2010). This work amplifies such recommendations by demonstrating the combined use of information from divers and local people; cadaver dogs; a desktop geological/hydrological study and WPR. More importantly, the study shows that an understanding of karstic groundwater in a lacustrine system can assist the search and explain results. The forensic search methods also demonstrate how limnologists may contribute to search and rescue and how search methods may help the study of lake (and other) aquatic systems.

2. The importance of the lacustrine environment to the case

The sequence of events leading up to and including this case is important to understanding the search scenario. The injured party (IP) was a 50 year old male with known illegal drug, alcohol and depression problems who lived with his wife, his children having left home. He was unemployed and had involvement with local drug-dealers whom (it was rumoured) he owed money: she worked part-time in a rural town in the west of Ireland (location anonymised). At 1800 h in September (autumn) 2006 his wife walked home from work to find their vehicle (a saloon car) absent with no specifics of where her husband may have gone. She alerted the police some 12 h later, who could not find him or the vehicle following an All Points Bulletin alert. 24 h later local volunteers began a search of the town. The vehicle was located that evening (some 50 h from the last known activity from the missing person – a sighting in the local shop) in a car park adjacent to a boating slipway at a nearby lake (Fig. 1). People visiting the car park, especially those fishing, knew the IP and his vehicle and presumed he was arriving early each morning to go fishing or sit by the lake.

3. The initial search of the lake

Upon discovery of the vehicle, it was searched and impounded by police, and the surrounding area searched. His home was re-visited and searched. No sign of the IP could be found: search dogs traced trails along the lake banks that led to no further discoveries. Theories explaining the disappearance included: suicide; a faked suicide and

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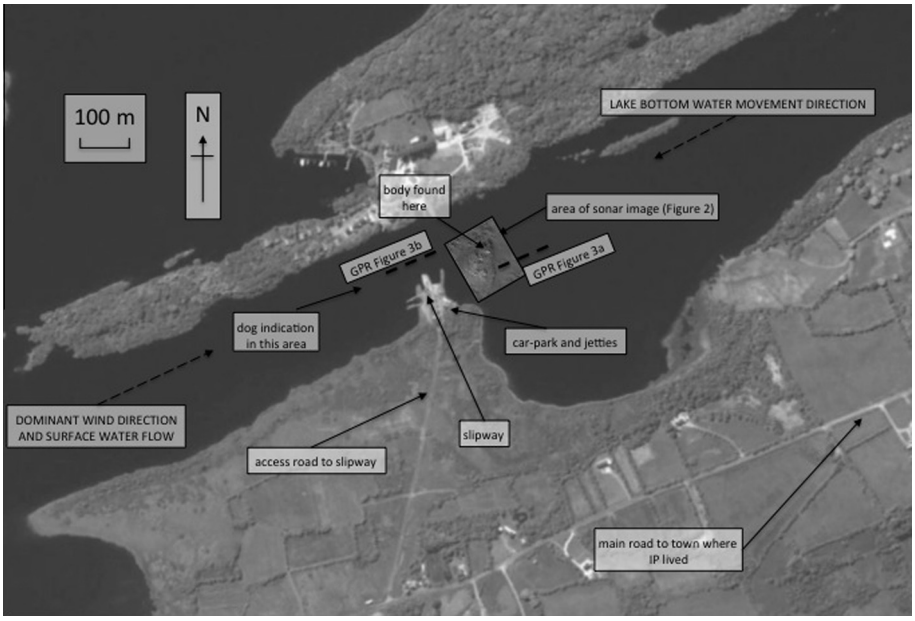

Fig. 1. Aerial photograph (courtesy Land and Property Services, N. Ireland, memorandum of understanding MOU203), showing the main access routes, car park and slipway (with jetties), current flow noted on site and by the police dive team and location of dog reaction and sonar and water penetrating radar (WPR, or water-borne ground penetrating radar) images shown in Figs. 2 and 3. Reproduced from Land and Property Services data with the permission of the Controller of Her Majesty's Stationery Office, © Crown copyright and database rights MOU203.

absconding (to avoid debt); homicide and accidental death. The location of the vehicle could have been a false lead and the IP was elsewhere (dead, injured or alive) but lead to the possibility that his body was in the water adjacent to the vehicle and car park/slipway (Fig. 1). Whilst terrestrial investigations were carried out, a search around the slipway car park was organised. The landward area around the car park comprises an access road to boating jetties (Fig. 1), fields with stone walls with isolated trees and a tree-lined lake bank. A search of these locations revealed nothing, so a water-search was required. Available search assets included three inflatable boats, fire brigade divers, cadaver dogs (trained for work on boats) and sonar. A dive team arrived first at the scene, followed by dog team and lastly, sonar. A standard dive-search protocol was deployed, with two divers working alternate 15 min shifts from one support boat in a zigzag pattern in a series of grids radiating north and west from the slipway. A second boat deployed the cadaver dogs, also in standard deployment as one dog was taken independently of the second. Any dog indication was located by GPS and a unique buoy as other buoys occur throughout the area. The sonar (StarFish 100 KHz) was deployed last (due to availability) in a series of ENE–WSW strips along the length of the lake west of the slipway, and N–S transects east of the slipway (Fig. 2a), as following

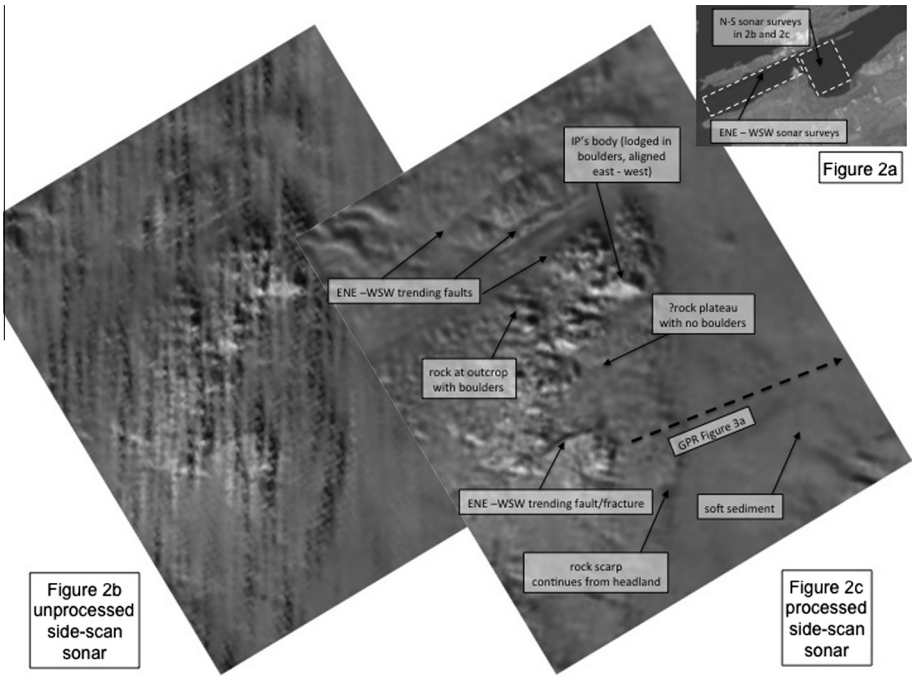

Fig. 2. (a) Location of the side scan sonar surveys. (b) Raw side scan sonar data from the area north-east of the slipway (location in Fig. 1), where an anomaly was observed. (c) ARC GIS (ESRI Software Educational Licence No. rocessed data (inverse distance weighting [IDW] with 12 nearest neighbourhoods), with interpretations.