THE CARTOGRAPHIC SANDBAGGER, OR, MAPPING A NORWEGIAN BLUE

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Abstract: A map used in five scenes of the first episode of the British TV espionage drama *The Sandbaggers* is identified as the then-current edition of a US military *Operational Navigation Chart* (ONC). The map's use by the characters, and its geographical and temporal appropriateness for the episode plot are examined.

INTRODUCTION

Maps are common props in films and television dramas. Generals pour over them. Spies photograph them. Detectives search them for clues. They are often used to establish a scene, whether on a wall as part of a set, or handled by the actors. With television and film drama (as opposed to the stage), closeups of a map can also be used to aid the narrative description of a journey, explain the local geography, or prepare the viewer for upcoming scenes such as battles or escapes. Just as some viewers enjoy engaging with a film by identifying the locations at which it was shot, or the vehicles it features, so cartophiles can pursue a similar supra-narrative engagement by identifying the maps used, and whether they were appropriate for the date, location or purpose of the action. Thus, the present paper identifies the map used in the first episode of the British television drama *The Sandbaggers*, and examines the appropriateness of the usages to which it is put by the characters.

THE SANDBAGGERS: FIRST PRINCIPLES

The Sandbaggers was a British spy drama created and written by Ian Mackintosh and produced by ITV franchise Yorkshire Television. Twenty 50-minute episodes were produced over three seasons 1978-80. Set during the then-contemporary Cold War, it followed the lives of the officers ('sandbaggers') and director of the British Secret Intelligence Service (SIS), dealing with vital and dangerous international missions. Besides its UK broadcast, the episode was sold to a number of countries including the US, Canada, Australia, West Germany, Italy and Israel.[1]

The first episode of Series 1, airing on 18 September 1978, was titled "First Principles". The Norwegian secret service has flown an aerial spying mission along its border with the USSR, radar fingerprinting in the vicinity of the Murmansk naval base and the Severomorsk missile submarine base. As a result of a bird strike, the aircraft loses lateral control and, unable to turn, continues into Russia and makes a forced landing. Having no specialist resources of his own, Lars Torvik, the Norwegian chief of service, who is visiting London, approaches SIS director Neil Burnside to request an immediate recovery operation before the Russians discover the intrusion.[2] Burnside refuses because the operation is too risky, and the Norwegians cannot offer anything in return; but simultaneously the Norwegian government cuts a deal with Whitehall, and Burnside is ordered to send in two of his men (Sandbaggers One and Two: Willie Caine and Jack Landy) to destroy the aircraft and its systems, and lead the crew of scientists back overland to Norway.

After planning and briefing, Caine and Landy are parachuted in;[3] but just as they are being dropped, Burnside learns that Torvik, frustrated at the initial SIS delay, had also approached the CIA who, just hours before, have sent in their own rescue mission without proper planning or any notification to the British.[4] The two Sandbaggers reach the wrecked plane just as time-delay fuses set by the American

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agents destroy it.[5] After deducing (somewhat remarkably) that the CIA have pre-empted them, the Sandbaggers realise that the straight-line route the Americans have taken will lead the scientists straight into a Soviet army camp. The Sandbaggers give chase; but just as they get within sight of their quarry, Russian soldiers crest the ridge and capture the Americans and Norwegians. The two Sandbaggers manage to avoid detection and eventually make it to Norway and safety. In the final scene, Burnside flies to Oslo to personally reprimand Torvik for his precipitancy: the first principle of a successful operation being proper planning.

MAP USE DURING THE EPISODE

While several of the London government office sets feature world maps on the walls, as scene-setting background, one map in particular is a more significant prop, used in five separate scenes.

(1) At 20:43-21:15,[6] the scene is an office in the Norwegian embassy in London. It opens with a close-up shot of Torvik's hand, holding a 12-inch Velos-brand wooden ruler, moving slowly across an aeronautical chart of the Russo-Norwegian border area (**Fig. 1**.). The map has been annotated with a straight line to indicate bearing of the aircraft's final radio squawk after ditching. The aircraft could be anywhere along the bearing, which runs southeast, from what appears to be a random spot in rural Norway 25 km west of Kirkenes, perpendicularly across the Norwegian border into Russia (**Figs. 1 & 6.**). The camera pulls up over a period of 4 seconds (the map drops off the bottom of the shot at 20:47), to focus on Torvik and Burnside. The latter dismisses Torvik's insistence that an aircraft fly down the line until it spots the ditched aircraft and then parachute a Sandbagger to the wreck. Burnside then he says he will borrow the map, picks it up, folds it in half three times over, and leaves.

(2) The very next scene (21:15-23:18) is set in Burnside's office. Burnside and Willie Caine (the latter holding another 12-inch wooden Velos ruler) are discussing the mission across Burnside's desk, on which the map is laid out but obscured from view by the low angle of the shot and the other objects on the desk. Jeff Ross, the CIA's London station chief, arrives seeking assistance for a job in Malta. Burnside declines and asks the CIA to ensure the Americans don't do anything in the Kola Peninsula for a few days. No detail or close-ups of the map are shown, although at 22:47-22:59 a chest-height horizontal shot of the three actors standing around the desk looks eastwards over the partly unfolded map, the colours and scale of which confirm it is the same map as in the first scene. The Kola peninsula is also clearly identifiable (**Fig. 2.**).

After Ross leaves, Burnside and Caine agree that the first step is to determine the exact position of the crashed plane, and only then plan the escape route from it. An RAF Jaguar is subsequently tasked with a mission to locate the wreck and to take aerial photographs to aid the overland route planning.[7]

(3) The third scene involving the map takes place in the SIS Operations Room (29:14-30:56). The location is established by initial shots of a world map on the wall, an operative writing on a white board, and others using teletype machines. The two Sandbaggers (both smoking!) are being briefed on their overland return route by two other officers at a desk on which the map is once more laid out. Burnside approaches and, in answer to his question "why the dogleg?", is told it is "to avoid Russian military positions". The party will need to head "NNW to make the [Norwegian] border", but a direct line from the crash would "hit a military camp", while further north is "a defended radar installation".[8] The dogleg runs the gauntlet between the two facilities, "putting 30 or 40 miles [48-64 km] on the journey" notes Landy discontentedly, although no total distance is mentioned.[9] This figure, however, is wildly inaccurate. As drawn (**Figs. 3 & 6.**), the two respective legs are approximately 20 and 65 km, for a total of 85 km; the inside angle of the dogleg is very obtuse (145°), so that the dogleg adds barely 3 km to the 82 km direct route.

The short discussion of the route is accompanied by a closeup of the map viewed from slightly east of south (29:49-29:57), with the hand of one of the briefing agents holding a biro and pointing first to the dogleg and then to two inked dots marking the two military facilities (**Fig. 3.**). A third dot 20 km west is left unmentioned, and Torvik's original plotted line of radio bearing has either been erased, or a fresh copy of the map is being used. The escape route is said to be "tundra-cum-moorland", with an expected speed of 3 miles (5 km) per hour (if the scientists are uninjured), and the escape is to be made in a single push as night travel alone is considered too risky. However, this too is inaccurate. An official US study of the Russo-Norwegian boundary notes:

> The boundary traverses primarily a heavily glaciated upland approximately 1,000 feet [300m] above sea level. … lakes abound in the upland. Many short rivers exist, most of which are interrupted by rapids and low waterfalls. … In the north, the vegetation is composed of isolated tundra and stunted birch forest, while the south is covered with dense stands of pine, larch, and spruce forests. (The Geographer, 1984, 2).

Thus the estimated speed of 5 km/h is grossly overoptimistic for a party of 10 or so, some possibly injured, attempting to cover 85 km (or more if required to detour around lakes or enemies) through forest, all while avoiding detection.

(4) The fourth map scene (41:33-44:15) takes place in Russia, as Caine and Landy attempt to catch up with the CIA agent(s) and scientists, whom they believe are unaware of the Russian military installations in the area. The Sandbaggers run along a rocky crest (which looks suspiciously like the rim of a disused English quarry!) then stop to take their bearings (42:00). Caine has been running with the folded map in his hand, Landy following wearing a loosely-strapped-on rucksack. In a close-up, Caine stabs the map with his finger (**Fig. 4.**) saying "they need to swing north just here to avoid the military camp" (42:17); but the location he is indicating is actually 420 km to the southwest, in Finland, just east of the Swedish border (**Fig. 8.**)! A comparison of the **Figs. 4 and 5** reveals that the way in which the map has been folded leaves the area where the story's action is actually taking place on the *reverse* side: Caine is simply pointing to the wrong side of the map, a blooper that both the actor and the director fail to notice.

Looking up, Caine and Landy now spot their quarry in the distance and give chase, but drop for cover as Russian troops come over the crest and arrest the CIA-led party.[10] Unarmed and unable to assist, the two Sandbaggers let the Russians and their captives move out of sight before turning for Norway themselves.

(5) In the final map-related scene (45:18-46:17), the map has no significant role. The two Sandbaggers, wet from rain, run through a pine forest in rugged terrain, Caine still clutching the folded map in his hand. They drop at the foot of two trees to catch their breaths. Caine unfolds the map a little and, from a near supine position, uses a prismatic compass to take a bearing (45:45) (but on what in a forest??). Checking his watch rather than the map, he tells Landy that they're "about seven miles [11 km] inside Norway". Both men grin, jump up and continue running down the slope.

THE MAP: IDENTIFICATION AND APPROPRIATENESS

The map used in these five scenes is the same one, or possibly multiple copies of a single map. In the first of the five scenes in which it appears, it is clearly identifiable as an *Operational Navigation Chart* (ONC), a 1:1,000,000 world series produced mainly by the US military, on very large sheets (42″ × 57.5″ = 107 × 146 cm) covering eight degrees of latitude.[11] Despite its fairly short time on screen, the chart is also seen to be the correct one for the storyline: sheet C-2 covering parts of Finland, Norway, Sweden and the U.S.S.R. between 64°-72° N, and 9°-36° E (**Fig. 5.**). Although produced by the military for military use, ONCs were also sold to the public. Thus the props manager would have been easily able to procure, likely from Stanford's in London,[12] not only a chart of the correct area for the story, but also the latest edition: edition 9, with a topographic base revised in 1976, air information current to 21 January 1976, and lithographed the following June.[13] The edition is confirmed by the fact that the first eight editions of this chart left sea areas white, except for a blue tint an inch or so wide

along the coast. Edition 9 was the first to give a uniform light blue tint to all sea areas, as is seen in the first three of the five scenes described above (**Figs. 1-3**.).

However, while the ONC map was perhaps suitable for initial plotting of the stricken aircraft's final radio squawk, it only shows contours at 1000-foot [305 m] intervals, with supplementary contours at 500 and 1500 feet [152 & 457 m] above sea level. Planning for the low-level Jaguar recce and the HS-748 insertion would have required at least the larger-scale 1:500,000 *Tactical Pilotage Chart* C-2B,[14] which had a contour interval of 250′ [76 m] below 1500′,[15] and then of 500′ beyond that (**Fig. 7.**). The then-current edition of TPC sheet C-2B (designated C-2B*G*, because it included a military UTM grid) was ed. 3-GSGS of 1974, which was also available to the public.[16] In common with many other aeronautical charts, the ONC and TPC both use the Lambert Conformal Conic projection, on which straight lines are very good approximations both of great circles and, to a slightly lesser extent, of rhumb lines (lines of constant bearing).[17] Thus radio bearings and courses of constant heading are easily plotted.

Even so, of much greater practicality to the Sandbaggers themselves, during briefing and escape, would have been the adjoining 1:250,000 *Joint Operations Graphic* (JOG) sheets NR35,36-8 *Kirkenes, Norway; Finland; U.S.S.R.* and NR35,36-11 *Verkhnetulomskiy, U.S.S.R.* covering 28°-32° E, and 69°-70°N and 68°-69°N respectively (**Fig. 9.**). Each JOG sheet came in two versions, Ground and Air, with elevations in metres and feet respectively, and a contour interval of 100m/~330′ with supplementary contours at 50m/~65′ intervals.[18] They therefore offered three times the elevation detail of the ONC. The current editions at the time would have been edition 1 for both versions of both sheets, compiled in 1969. While JOGs would certainly have been available to the SIS *characters* via the Ministry of Defence, their public availability has not been as open as for TPCs and ONCs, so the show's prop master may not have been able to procure them for use in the production. Besides their much-improved scale and detail, JOGs would also have been much more practical for physical use during the overland escape, due to their much smaller sheet size (56 × 75 cm); but for the same reason, they would not have been quite so visually impressive on television, or shown such an easily-identifiable area in the office scenes, as did the larger sheet size of the ONC.

Larger scale mapping likely available to SIS would have been of no greater use. Norway's own 1:50,000 series (M711) had next to no detail in Russia on the sheets covering the border until the editions of *ca*.2010. The Soviets, on the other hand, were producing very detailed[19] topographic mapping at a variety of scales (1:1,000,000; 1:500,000; 1:200,000; 1:100,000; 1:50,000; 1:25,000 and 1:10,000), but even if the SIS had access to the appropriate sheets (very unlikely[20]), it would have been too compromising to equip the Sandbaggers with them.

Apart from the inappropriate use of the ONC for the overland escape route briefing (map scene 3), and Caine pointing to Finland instead of Russia when chasing the CIA rescue party (map scene 4), the biggest cartographic blooper is in map scene 5, when Caine requires a compass bearing to determine whether the Sandbaggers have made it back to Norway. That he only determines they are back on NATO soil when they are already more than 10 km beyond the Russian border is patently unrealistic; but assuming that that was the first point at which he could make a determination, it suggests the boundary there was a straight-line boundary in difficult and heavily forested terrain. However, in fact about 78%, or 153 km, of the entire 196-km Russo-Norwegian land boundary follows watercourses: 110 km in the south along the Pasvikelv[a] River (Russian: Паз or Патсойоки, *Paz* or *Patsoyoki*), and 43 km in the north along the Jakobselv[a] (Russian: Ворьёма, *Vor'yema*) to the Barents Sea. The remaining 43 km comprises two sections of straight (*i.e*. geodesic) lines: the first 6 km from the Finnish tripoint to the Pasvikelv; and the section linking the two river sections, which forms a Russian salient around Boris Gleb, site of a 16th-century Orthodox mission (The Geographer, 1978, 2-3). However, to reach this salient the Sandbaggers would have had to pass between the mining towns of Nickel and Zapolyarny, surely too risky. Further south, the dogleg route originally planned required a crossing of the reservoir formed in 1964 by the hydroelectric dam at Skogfoss. This lake is between 100 m and 1 km in width and

over 20 km long. Apart from the difficulty in crossing this unseen (especially with half a dozen or more scientists, some possibly injured, in tow), it would have been quite obvious to the men when they had reached Norway and safety.

CONCLUSION

The debut "First Principles" episode of the British spy drama *The Sandbaggers*, featured several scenes involving edition 9 of *Operational Navigation Chart* sheet C-2, a large-format 1:1,000,000 military aeronautical chart on open public sale. Its use was not, to quote Gilbert and Sullivan (1885, 40) "merely corroborative detail, intended to give artistic verisimilitude to an otherwise bald and unconvincing narrative", for despite the short durations of its on-screen appearances, the large sheet size and clear colouring of the map enabled it to visually establish for the viewer both the location of the ensuing action, and the geometry and geography necessary to understand it. It was also a real, current, and geographically suitable choice of map, and in the first and second of the five scenes in which it appears, its use by the characters was appropriate, although the larger-scaled *Tactical Pilotage Chart* sheet C-2B would have been more suitable. Thus, these scenes successfully balanced the needs of plot realism and authenticity with those of the television medium itself. However, the use of an ONC for planning an overland route for a party on foot, in the third of the five map scenes, was inappropriate: two sheets from the 1:250,000 *Joint Operations Graphic* series would have been much more suitable for joint air/ground planning, briefing, and for overland navigation. Here, apart from the required JOGs not yet being publicly available, the needs of the medium for a rapid, visually-clear cartographic depiction of the upcoming action trumped the internal realism of the plot. However, the subsequent use of the ONC by the ground party inside Russia was simply ridiculous: not only was a much larger-scale map needed, but Caine's indication of a point in Finland, and the inexplicable method and place in which he took the bearing to confirm he was out of Russia, are errors the director should have picked up and had reshot. Nevertheless, given the tight budgets and time-frames for television productions such as *The Sandbaggers*, the producers and crew of a programme created for a single broadcast (and perhaps a couple of repeats) in each of the dozen or so countries to which it was sold, can be proud that almost half a century later, their work remains of interest not only to fans of espionage drama and historians of Cold War popular culture, but also to those, like myself, whose hobbies include the cartographic equivalent of train-spotting.

ACKNOWLEDGEMENTS

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Figure 1. First map scene (20:44). Torvik indicates the bearing of the last squawk from the ditched aircraft. *ONC* sheet C-2 ed.9 looking south, with top and bottom 25% folded underneath leaving central 50% visible.

Figure 2. Map scene 2 (22:53). Ross, Caine and Burnside in Burnside's office. *ONC* on desk, folded as in previous scene (**Fig. 1.**), with north towards Ross. Barents Sea, Kola Peninsula and Kandalaksha Gulf are visible.

Figure 3. Map scene 3 (29:56), operations briefing. The planned escape route (line) passes between 2 dots (military camp & radar facility). The third dot is unexplained. Note full blue wash in Barents Sea, confirming the sheet is the 9th edition.

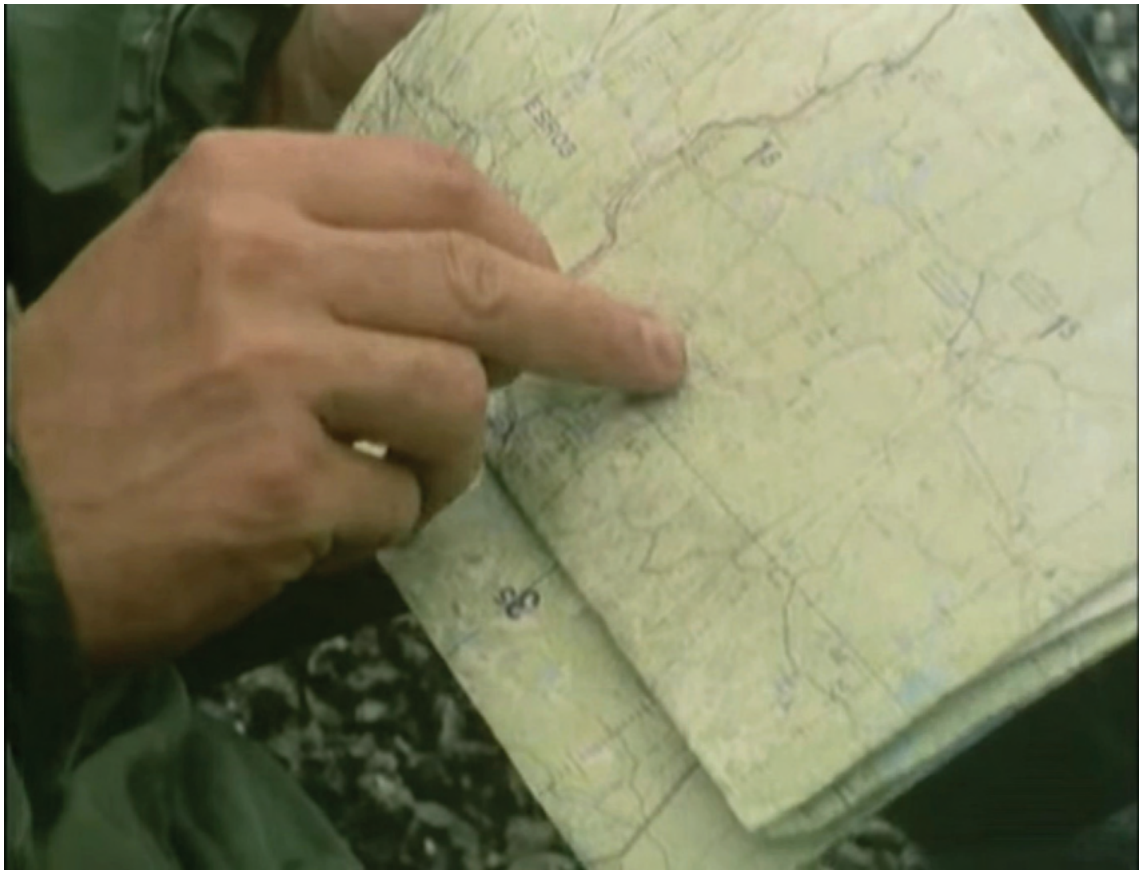

Figure 4. Map scene 4 (42:18). "They need to swing north just here to avoid the [Russian] military camp," but Caine is mistakenly pointing to a spot in Finland, 40km E of the Swedish border and a similar distance N of the Gulf of Bothnia.

Figure 5. *Operational Navigation Chart* (*ONC*), 1:1,000,000, sheet C-2, edition 9, 1976.

Figure 6. Detail of ONC C-2 ed.9 (1976) annotated to show radio bearing (dashed line) from **Fig. 1**, and planned escape route (solid line) from **Fig. 3**. A = ditched aircraft; C = Russian military camp; R = defended radar installation; X = mystery dot; solid circles: real Soviet military airbases; dashed circle: real Soviet civil airport.

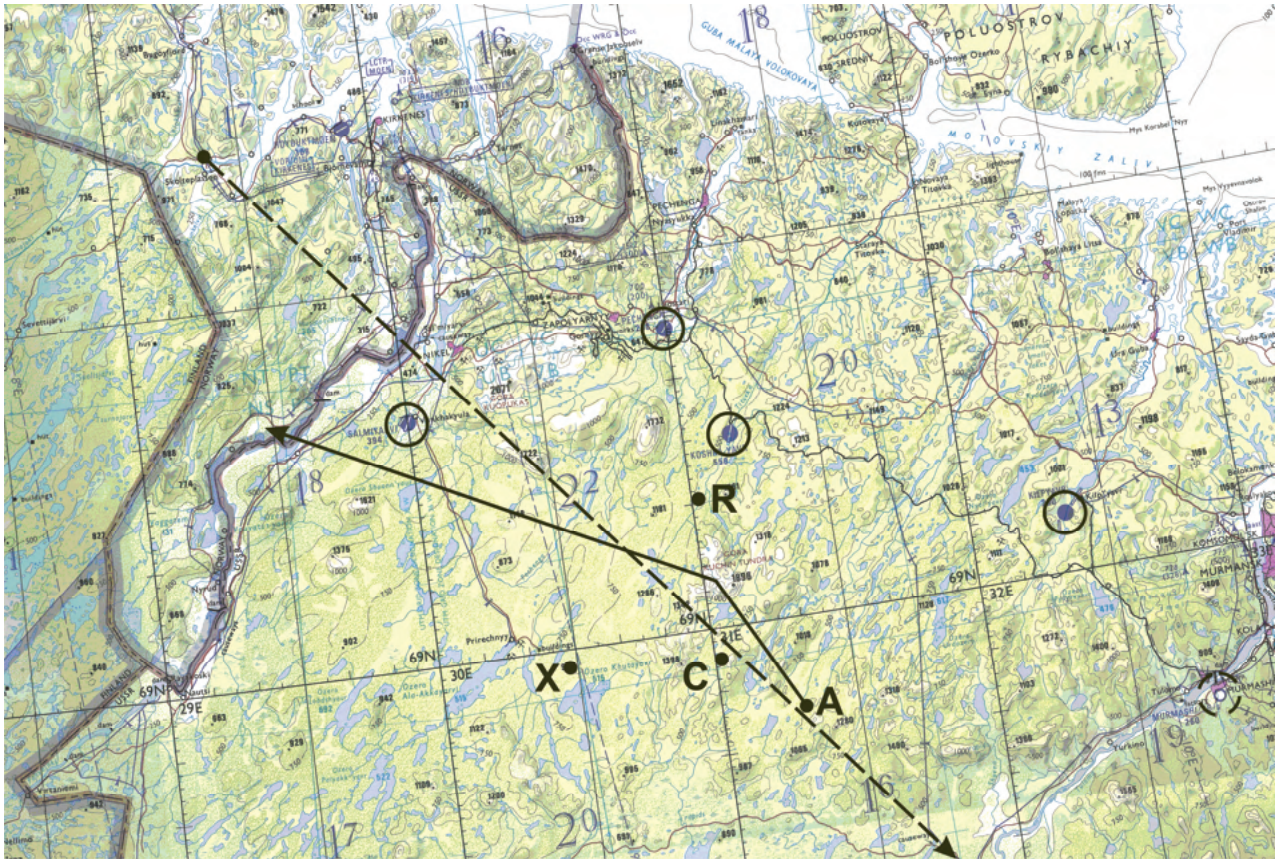

Figure 7. Detail of TPC C-2BG ed.3-GSGS (1974), annotated as per **Fig. 6**.

Figure 8. Detail of ONC C-2 ed.9 showing the extent of map visible in **Fig. 5**. North coast of Gulf of Bothnia at bottom edge, with Swedo-Finnish boundary running north south. Circle indicates point where Caine taps map.

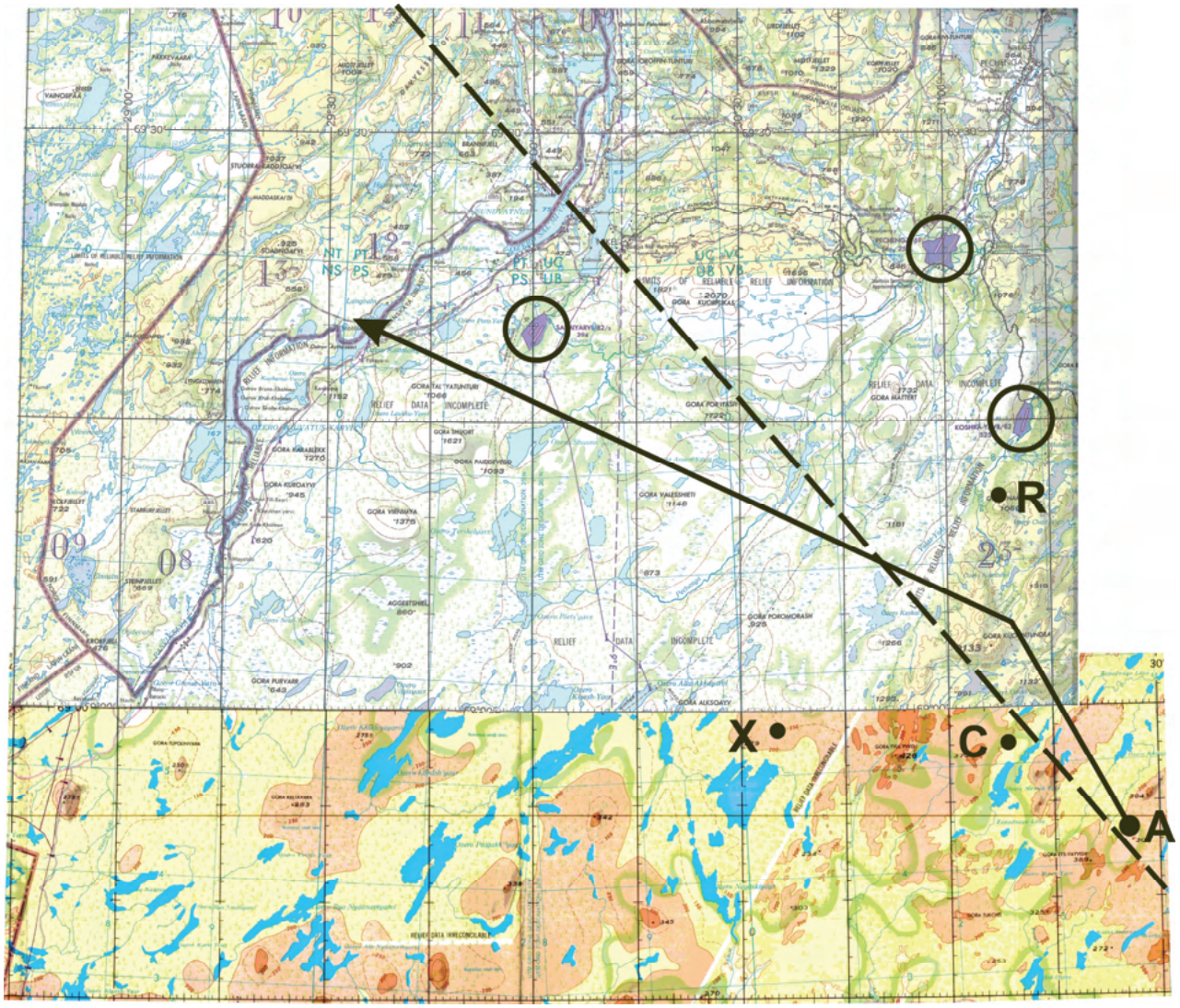

Figure 9. Montaged detail of JOG Air sheet NR35,36-8 (top) and JOG Ground NR35,36-11 (bottom), both ed.1 1969, annotated as per **Fig. 6**. The riverine Russo-Norwegian boundary with its several hydroelectric reservoirs is clearly seen.

NOTES

[1] These countries were mentioned in the Wikipedia entry for *The Sandbaggers*. ITV have not responded to my request for information on which countries bought the programme, but Ireland, New Zealand, Netherlands, and the Scandinavian countries likely did so.

[2] This episode seems to have been inspired by the shooting down of Korean Airlines flight 902 over the Kola Peninsula on 20 April 1978. Indeed, when Torvik first seeks Burnside's help, Burnside mentions that real-life incident as an example of the sensitivity of the region. Flight 902, a Boeing 707 with 97 passengers and 12 crew, was scheduled from Paris to Seoul via Anchorage, but developed compass problems when over Ellesmere Island in the vicinity of the north magnetic pole, and ended up turning southeast, flying over Spitzbergen and the Kola peninsula. Soviet fighters intercepted it, and shot off part of one wing with a missile before the aircraft made a forced landing on a frozen lake in northern Karelia, 150 km from the Finnish border. Two passengers, a Korean and a Japanese, died as a result of the missile strike. All but two of the survivors were flown to Helsinki a couple of days later, but the pilot and navigator were interrogated for a further week before being flown out to Copenhagen (Rueckert, 2020).

[3] From an RAF Hawker Siddeley HS748 Andover, a twin-engined turboprop medium transport. In use from 1962, the aircraft was still in production at the time of filming, the last RAF examples retiring in the 2000s. The series 2A had a range (with reserves for 370 km plus a 45-minute hold), of 3100 km (Taylor, 1977, 183).

[4] The CIA apparently located the downed Norwegian aircraft using "comparative satellite tracings".

[5] The airframe used for shots of the ditched Norwegian aircraft was an ex-RAF Percival Pembroke light communications/ transport aircraft, registration WV742, which had been converted to Ground Instructional Airframe 8111M, and issued to the Air Training Corps at Andover. Yorkshire Television had it repainted in Royal Norwegian Air Force colours, and transported to near Cowpers Cross on Ilkley Moor, West Yorkshire, where it was denotated (Allenby, 2023). In production 1952-58, Pembrokes were designed for aerial photography and surveying work, so the airframe was not

inappropriately cast as a spy plane. However, although purchased by the air forces of Denmark, Sweden and Finland, Pembrokes were never operated by the Norwegian military (Bridgman, 1956, 85).

[6] All timings are based on the copy of the episode (total duration 50m31s) uploaded to Youtube by Harry the Hatchet Hopkirk on 6 June 2023, which seems to have slightly better visual quality than other uploads of the episode. Timing differences between the different uploads are a function of whether the opening/closing titles and the two sets of advertising break titles during the episode ("End of part one"/"Part two" ; "End of part two"/"Part three"), have been reduced in duration or removed. The Hopkirk upload appears to retain all titles in full.

[7] A joint Anglo-French design, the single-seat SEPECAT Jaguar fighter was in service with the RAF 1974-2007. Capable of speeds up to Mach 1.1 (1350 km/h) at sea level, and Mach 1.5 (1593 km/h) at 11,000m, with a typical attack radius of 575-815 km using internal fuel or 835-1315 km with external fuel pods, and a ferry range of 4210 km with external fuel (Taylor, 1979, 99). At the time, Jaguars equipped 8 front-line RAF squadrons: 5 in Germany and 3 in the UK. Squadrons 2(AC) in Germany and 41 at Coltishall, in Norfolk, were reconnaissance squadrons, which could carry a camera pod containing horizon-to-horizon optical cameras as well as infra-red line-scanners (IRLS) for poor weather and night capability. For full camera details see Taylor, 1979, 98-99. Although Norway was a NATO member, it refused to host NATO bases in order to assure the Soviets that the alliance was purely defensive. Thus, with the possible exception of whatever aircraft the CIA used in their insertion, the RAF Jaguar and Andover sorties would have had to have been made from the UK, refuelling *en route*.

[8] No attempt is made to explain why this, and any other Soviet radar facilities, did not detect the initial Norwegian incursion, let alone the subsequent RAF Jaguar photo mission, CIA insertion, or the final RAF Andover insertion, all in the same area. Getting all four aircraft into Russia, and the latter three safely out again, without detection along what the characters themselves admit is an indefensible NATO border, seems incredible. But while there is no indication the Russians scrambled fighters during any of the incursions, the Russian infantry who crest the ridge above the CIA-led party at 43:23 seem to be on the hunt for something, and not simply out on exercise.

[9] At 28:27 in an earlier scene, Burnside tells the head of SIS (Sir Richard Greenley, known as "C"), that the Norwegians are "about 50 miles" (~80 km) inside Russia, a figure which matches the distances marked on the map in map scene 3.

[10] The number of Norwegians to be rescued, and the number of CIA agents inserted, are never mentioned. However, at 26:53-27:04, a brief sequence of the scientists and crew waiting next to their ditched aircraft as the Jaguar passes overhead includes 7 men: 2 crew in blue flight dress and 5 scientists in civvies (of whom one has a head bandage, one an arm in a sling, and one is wrapped in a blanket). Subsequent sequences of the American-led overland escape at 42:46-53, 42:59-43:03 and 43:23-44 show the party now number ten, of whom three in olive drab (two in the lead plus tail-end Charlie) must be the CIA agents, bookending the two crewmen and the five (surprisingly elderly-looking) Norwegian scientists.

[11] ONCs were first produced 1961, as an improved specification of the equivalently-scaled *World Aeronautical Chart* (WAC), and *Topographic Navigation Chart* (TNC), and used WAC sheet sizes (56 × 75 cm) and numbering. Increasing aircraft range made this sheet size increasingly impractical, so was rapidly replaced by the larger (107 × 146 cm) sheets and revised numbering. They use the Lambert Conformal Conic projection over areas below 80° latitude, and Polar Stereographic projection beyond that. Printed in an average of nine colours, ONCs depict vegetation in flatter areas only, ensuring relief, the most vital feature for aeronautical use, is easily readable. Rather than employing hypsometric tinting, four tints are used to depict *terrain characteristics*: green for flat or relatively level areas in lower elevations; yellow-green for level areas at higher elevations such as plateaus; light buff indicates hilly terrain; and yellow rolling to mountainous terrain. Relief shading is also used. Over this topographic base, a purple overprint shows airfields with their runway lengths and orientations, radar, beacons and other navigational facilities, and various types of airspace. Aerodromes are symbolised, with elevation figures given for all types, but runway patterns shown only for major aerodromes with hard-surface runways of 3,000′ [1000 m] or more, and just the numerical length in hundreds of feet for others. Additionally, the centre of every 1° square at low latitudes, and every 2°×1° square at higher latitudes, contains a large purple number followed by a smaller superscript number, indicating the highest known elevation (whether terrain feature or structure) in that square, measured in thousands and hundreds of feet. ONCs had a partial margin, the map detail bleeding to the north and east edges of the sheet, allowing easy montaging of adjoining sheets.

"The ONC supports high-speed radar navigation requirements of first-line aircraft at medium altitudes. Other uses include visual, celestial and radio navigation; mission planning and intelligence briefings. This series is also used as the basic chart for application of special overprints required of support combat mission planning of strategic operational concepts. In the absence of TPC's, these charts also satisfy enroute visual and radar navigation requirements for low altitude operations. They are also utilized in the preparation of visual cockpit displays/filmstrips essential to aerospace navigation of high performance weapons systems" (DMA, 1980, 36-IV).

[12] The *Stanford Reference Catalogue* (1969) produced by London mapseller Stanford's, priced ONCs at 12*s* each (= 60*p* following decimalisation in 1971). Unfortunately Stanford's have been unable to locate any later catalogues or price lists in their archives, so the exact price of an ONC in 1978 in unknown (pers. comm., Vivien Godfrey, Stanford's 2 Sept. 2023).

[13] Most editions were produced by the US Aeronautical Chart and Information Center (ACIC) and, after 1972, the Defence Mapping Agency Aerospace Center (DMAAC), with some editions reprinted by the UK Ministry of Defence (MOD), Ordnance Survey (OS), or Mapping and Charting Establishment, Royal Engineers (MCE(RE)). The German Militärgeographisches Amt (DMG) issued at least 4 editions of its own, on sheets designated C-2/DMG. The final ed.13 of ONC sheet C-2, and its neighbour sheet C-3 ed.7, were also used as the base for several editions of a 2-sheet series

USSR [from 1998: *Russian Federation*] – *Claimed 12-Mile (Nautical) Limit* (GSGS 5657), overprinted in carmine.
Known editions and issues of ONC sheet C-2 are given in the following table.

Edition	**Production**	**Aero. info.**	**Printing**	**Notes**
1	Base info Apr. 1958	23 May 1960	ACIC 7/60	NLA
2	Base info Apr. 1958	6 Mar 1961	ACIC 3/61	NLA
3	Base info. comp. Sep. 1960	5 Jun 1962	ACIC 6/62	LC
4	Base info. comp. Sep. 1960	12 Mar 1963	ACIC 4/63	Bod., LC
5	Base info. comp. Sep. 1960; rev. Aug. 1964	20 Aug 1964	U.P. 1/65	BL, SB
1-GSGS	Prod. 1965 from USAF ONC C-2 base… Sep. 1960	Apr 1965	SPC, RE 6/65	TNC sheet C-2. "Revision to roads, railways, coastline and height" Bod., NLS
5/DMG REV	Base info. comp. Sep. 1960	10 Mar 1966	DMG 6/66	Sheet C-2/DMG. On ed.4 ACIC 4/63 base. BL
6	Base info. comp. Sept. 1960; rev. Apr. 1966	6 Jul 1966	[ACIC 5/66]; ACIC 8/66; OS for MOD 6/68	"Contour evaluation overprint no.4, May 1964" [magenta] NLA & SB (8/66 printing); BL, Bod., NLS (6/68 printing); DMG printing (next entry) is on 5/66 base.
6	Base info. comp. Sept. 1960; rev. Apr. 1966	10 Mar 1968	DMG 5/68	Sheet C-2/DMG; on ed.6 ACIC 5/66 base. "Contour evaluation overprint no.4, May 1964" [magenta] BL
6-GSGS	*1968*	*?*	*?*	*Card index, MOD, UK.* *May be MOD 6/68 ed.6 reprint above.*
7	Comp. Sep. 1960 [no rev. date]	5 Nov 1969	ACIC 12/69; MCE(RE) 1/71	"Contour evaluation overprint no.1, May 1964" [magenta] LC (12/69 printing); Bod., NLS (1/71 printing); BL (both printings).
7	Comp. Sep. 1960 [no rev. date]	5 May 1971	DMG 8/71	Sheet C-2/DMG. On ed.7 ACIC 12/69 base. "Contour evaluation overprint no.1, May 1964" [magenta] BL
7-GSGS	*1970*	*?*	*?*	*Card index, MOD, UK.* *May be MC(RE) 1/71 ed.7 reprint above.*
8	Comp. Sep. 1960 [no rev. date]	23 Jun 1971	JC 3/72	Bod., NLA, NLS
9	Comp. Sep. 1960; rev. Jan. 1976	21 Jan 1976	DMAAC 6/76	**Used as prop in "First principles".** Bod., NLA, NLS
10	Comp. Sep. 1960; rev. Oct. 1979	24 Oct 1979	DMAAC 4/80	Bod., NLA, NLS
10	Comp. Sep. 1960; rev. Oct. 1979	24 Oct 1979	DMG 2/82	Sheet C-2/DMG "Published… 1981". BA, SB
11	Comp. Sep. 1960; rev. May 1982	1 Jun 1982	DMAAC 1/83	"Revision limited to aeronautical information and correction of CHUM conditions". BL, Bod., LC
11	Comp. Sep. 1960; rev. May 1982	1 Jun 1982	DMG 3/84	Sheet C-2/DMG "Published… 1983". "Revision limited to aeronautical information and correction of CHUM conditions". BA, BL, SB
11-GSGS	*1983*	*?*	*?*	*Card index, MOD, UK.* *May be an unsighted UK reprint of ed.11 above.*
12	Comp. Sep. 1960; rev. Apr. 1986	21 Mar 1986	DMAAC 10/86	BA, Bod., NLA, NLS, SB
13	Comp. Sep. 1960; rev. Oct. 1989	21 Mar 1986	DMAAC 12/89	Military grid reference system added. BA, PCL (image online), SB
1-GSGS	Comp. Sep. 1960; rev. Oct. 1989	21 Mar 1986	[1990]	Series GSGS 5657. Overprint of ONC ed.13. No copies located.

2-GSGS	Comp. Sep. 1960; rev. Oct. 1989	21 Mar 1986	[1996]	Series GSGS 5657. Overprint of ONC ed.13. No copies located.
3-GSGS	Comp. Sep. 1960; rev. Oct. 1989	21 Mar 1986	Mil. Svy. (UK) 5/99	Series GSGS 5657. Overprint of ONC ed.13. LC

The Notes column shows all editions held by the Abteiling Militärarchiv of the German Bundesarchiv (Freiburg), the Bodleian (Oxford Uni.), the National Libraries of Australia and Scotland, and the Staatsbibliothek zu Berlin (noted as BA, Bod., NLA, NLS, and SB respectively), and the libraries at which I located other editions (BL = British Library; LC = Library of Congress; PCL = Perry Castañeda Library, Univ. of Texas at Austin). An old card index at the MOD suggests that editions 6, 7 and 11 were revised and reissued in the UK as ed.6-GSGS, 7-GSGS and 11-GSGS, but as no copies of these have been located, I suspect these are simply references to the unrevised British reprintings of the corresponding US editions, of which I have found copies of eds. 6 and 7, but not 11.

[14] Similar in style to ONCs, from 1964 TPCs replaced *USAF Pilotage Charts* (PC), which were originally WAC-sized and used WAC numbering, then briefly became ONC-sized with ONC numbering. Each ONC is subdivided into four TPCs, which all use the same standard parallels as the ONC, and the same numbering, but with A, B, C or D appended to the end of the sheet number. TPCs use the same projection as their parent ONC, have the same partial margins, and depict similar information, but unlike ONCs, TPCs incorporate hypsometric tinting.

"The TPC supports high-speed, low altitude radar, and visual navigation of high-performance tactical and reconnaissance aircraft at low through medium altitudes. Other uses include mission planning and analysis, intelligence briefings, and preparation of visual cockpit displays/filmstrips essential to aerospace navigation of high-performance weapon systems." (DMA, 1992, 6-24).

[15] Except within Norway, where the 1250′ [381 m] contour was not shown.

[16] The 1969 *Stanford Reference Catalogue* also priced TPCs at 12*s* each.

[17] Technically, on this projection, great circles are slightly s-shaped, while rhumb lines are concave towards the poles. But at the relatively large scales (1:1,000,000 and 1:500,000) and over the small distances considered here, use of straight lines involves insignificant error.

[18] In the 1960s JOG series 1501 replaced the various 1:250,000 topographic series produced by the UK Ministry of Defence (GSGS numbering) and US Army Map Service (NATO-numbering) (e.g. GSGS 4743/M515 Northern Europe series for the area under discussion), while JOG series 1501 Air replaced the Aeronautical Chart (AGC) which in turn had replaced the USAF Aeronautical Approach Chart (AC). JOGs between 84°N and 80°S used the Transverse Mercator projection, and the Polar Stereographic projection at higher latitudes. Like ONCs and TPCs, JOGs have partial margins. They use hypsometric tinting and relief shading, and depict runways and aerodrome boundaries to scale. The Air version includes maximum elevation figures similar to ONCs and JOGs, within 15′ or 30′ graticule squares. At some point, the separate Air and Ground series began to be replaced by a Combined Joint Operations Graphic (series 1501C), but this change was later reversed.

"The Series 1501 AIR is the aeronautical chart version of a coordinated worldwide series at 1:250,000 scale required to support international and joint service air/ground tactical operations, pre-flight and operational planning, training, pilotage or operational functions, and intelligence briefings." (DMA, 1992, 6-2).

[19] Though, at least for foreign countries, it was not always accurate: see Whyte 2020 & 2022.

[20] Soviet citizens themselves could not obtain even 1:1,000,000 scale mapping until 1989, the same year the USSR collapsed and Soviet military mapping became available to the West (Davies & Kent, 2017).

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