

香港環境輻射監測技術報告第 31 號
**Technical Report No. 31 on
Environmental Radiation Monitoring in Hong Kong**

香港環境輻射監測摘要
**Summary of
Environmental Radiation Monitoring
in Hong Kong**

2010

呂振文 李中和
C.M. Lui and C.W. Lee

香港天文台
Hong Kong Observatory

©香港特別行政區政府
© Hong Kong Special Administrative Region Government

二零一一年九月出版
Published September 2011

香港天文台編製
香港九龍彌敦道134A號

Prepared by:
Hong Kong Observatory
134A Nathan Road
Kowloon, Hong Kong

本刊物的編製和發表，目的是促進資料交流。香港特別行政區政府(包括其僱員及代理人)對於本刊物所載資料的準確性、完整性或效用，概不作出明確或暗示的保證、聲明或陳述；在法律許可的範圍內，對於提供或使用這些資料而可能直接或間接引致任何損失、損壞或傷害(包括死亡)，亦不負任何法律承擔或責任(包括疏忽責任)。

本刊物內容曾提及一些生產商的產品，這並不存在任何讚許或建議使用該產品的意義。

未經香港天文台同意，不得翻印本刊物任何部分。

This publication is prepared and disseminated in the interest of promoting information exchange. The Government of the Hong Kong Special Administrative Region (including its servants and agents) makes no warranty, statement or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, and in so far as permitted by law, shall not have any legal liability or responsibility (including liability for negligence) for any loss, damage, or injury (including death) which may result, whether directly or indirectly, from the supply or use of such information.

Mention of product of manufacturer does not necessarily constitute or imply endorsement or recommendation.

Permission to reproduce any part of this publication should be obtained through the Hong Kong Observatory.

摘要

香港天文台環境輻射監測計劃在二零一零年踏入第二十四年。本年報收錄了監測計劃在二零一零年的主要工作內容、測量方法及結果。年報亦介紹了新的工作項目、轉變和引進的新措施。

在二零一零年，天文台的輻射監測網絡錄得的環境輻射水平均在正常本底變化範圍之內。與過去的情況相若，天文台在不同的環境及食物樣本中測量到微量的人工放射性核素，包括銻-137、氙、銻-90及鈾-239。分析結果與廣東核電站及嶺澳核電站運作之前的結果並沒有顯著分別。相信這些放射性核素主要來自一九四五至一九八零年間的大氣核武試驗。

二零一零年的測量結果顯示，自廣東核電站及嶺澳核電站運作以來，香港的環境輻射水平、環境樣本及市民日常食用的食品中的人工放射性核素活度並沒有可測量到的變化。

ABSTRACT

The Environmental Radiation Monitoring Programme of the Hong Kong Observatory entered its twenty-fourth year in 2010. This annual report incorporates salient features of the work of the programme during 2010, including a brief report on measurement method and results, highlights of relevant new work, changes and new measures introduced.

The ambient radiation levels in Hong Kong in 2010 as measured by the Observatory radiation monitoring network were within the normal background range. As in the past years, traces of artificial radionuclides, namely caesium-137, tritium, strontium-90 and plutonium-239, were detected in various environmental and food samples. The levels of all these radionuclides were not significantly different from those recorded before the Guangdong Nuclear Power Station and Lingao Nuclear Power Station came into operation. Their existence could primarily be attributed to atmospheric nuclear weapon tests from 1945 to 1980.

Based on the results, it is concluded that there was no measurable change in 2010 in ambient radiation levels and activities of artificial radionuclides in the Hong Kong environment and foodstuffs consumed by Hong Kong people, compared with those before the operation of the nuclear power stations.

目錄

	頁數
圖目錄	6
表目錄	7
1. 引言	8
2. 取樣、測量及質量保證	9
2.1 環境輻射水平的直接測量	9
2.2 食物及環境樣本取樣安排	11
2.3 食物及環境樣本的實驗室測量	13
2.4 本底輻射監測計劃(BRMP)及 環境輻射監測計劃(ERMP)的測量值比較	13
2.5 質量保證	14
3. 測量結果及結論	15
3.1 測量結果	15
3.2 結論	18
鳴謝	19
參考文獻	20

圖

	頁數
圖 1. 實時監測環境輻射的測量點	37
圖 2. 熱釋光劑量計網絡及二零一零年 環境樣本收集點	38
圖 3. 空中輻射監測系統在大鵬灣海面上空測量到的 計數率隨高度的變化 (二零一零年八月三日)	39
圖 4. 空中輻射監測系統在西貢地區上空測量到的 計數率隨高度的變化 (二零一零年八月三日)	40
圖 5. 空中輻射監測系統在吉澳上空測量到的鉀-40 放射性水平(測量高度距離地面約一百米) (二零一零年十月五日)	41
圖 6. 二零一零年內進行四次高空輻射探測的平均 大氣放射性垂直廓線 (探測日期為：三月四日、 七月八日、九月二日及十二月二日)	42

表

	頁數
表 1. 樣本取樣及分析概要	43
表 2. 食物樣本概要	48
表 3. 主要量度參數概要	50
表 4. 輻射監測網絡及熱釋光劑量計網絡在二零一零年錄得的環境伽馬劑量率	52
表 5. 平洲自動伽馬譜法系統在二零一零年的輻射測量結果	54
表 6. 二零一零年宇宙輻射引致的伽馬劑量率測量結果	54
表 7. 二零一零年食物及環境樣本中之人工伽馬放射性核素的可測量伽馬活度測量結果	55
表 8. 二零一零年食物及環境樣本的可測量氡活度測量結果	56
表 9. 二零一零年食物及環境樣本的可測量鋇-90 活度測量結果	60
表 10. 二零一零年食物及環境樣本的可測量釷-239 活度測量結果	62
表 11. 二零一零年整體測量結果概要	63

1. 引言

香港天文台早於一九六一年開始監測香港的環境輻射水平，並且參與由國際原子能機構（IAEA）和世界氣象組織（WMO）舉辦的國際性環境輻射監測計劃。由於在廣東大亞灣興建核電站，天文台於一九八三年開展了一項全面的計劃，以監測核電站運作前後在香港的環境輻射水平。

該輻射監測計劃分為兩個階段。第一階段稱為「本底輻射監測計劃」（BRMP），於一九八七年至一九九一年這五年間進行，務求在一九九四年廣東核電站（位置可見圖 1）投產之前，確定香港的本底輻射水平，作為基準線，以判別核電站運作後可能為香港輻射水平帶來的變化。一九八七年至一九九一年 BRMP 的監測結果可見於本底輻射監測計劃的報告（香港天文台，1992）。監測計劃的第二階段稱為「環境輻射監測計劃」（ERMP），由一九九二年開始運作，內容涵蓋 BRMP 內的所有重要項目，並因應所得經驗於採樣及測量工作上作出修訂。ERMP 是一項持續進行的計劃，目標是監測香港環境輻射水平的任何長期變化，尤其是因廣東核電站與嶺澳核電站分別在一九九四年及二零零二年運作後而可能帶來的變化。

一九九二年至二零零二年的所有監測結果已在監測計劃的年報發表（<http://www.hko.gov.hk/publica/pubrnc.htm>）。自二零零三年開始，監測計劃的年報實行精簡化，年報只收錄計劃的重點，包括測量方法、測量結果的總結、該年新工作的摘要、以及實施了的轉變和新措施。讀者可參閱以往的年報，以瞭解計劃的採樣、測量及質量保證工作的詳情。

本報告的第 2 章介紹監測計劃的取樣工作，以及環境輻射水平、食物和環境樣本中放射性的測量方法及儀器，並且總結了質量保證工作。第 3 章則臚列測量結果及所得的結論。

2. 取樣、測量及質量保證

環境輻射監測計劃的焦點是在監察大氣、地面和水體三個主要照射途徑。測量工作包括兩個主要部份。第一部份是直接測量香港的環境輻射水平，第二部份則是測量香港環境樣本及市民日常食物中，因廣東核電站及嶺澳核電站的運作而可能出現的人工放射性核素。圖 1 顯示實時測量環境輻射的地點，圖 2 所示為二零一零年其他環境伽馬輻射的測量點及環境樣本的收集點。表 1 列載二零一零年的取樣及分析概要。

2.1 環境輻射水平的直接測量

2.1.1 輻射監測網絡

自 ERMP 開展以來，輻射監測網絡由十個固定站組成(圖 1)，監測香港境內的環境伽馬輻射水平。每個站均裝設一個高壓電離室(Reuter-Stokes Model RSS-131 environmental radiation monitor)，不斷測量環境伽馬輻射劑量率，並每一分鐘將數據傳送至天文台總部。

2.1.2 熱釋光劑量計網絡

香港天文台於 1980 年代末開始使用熱釋光劑量計，測量長時間累積的環境伽馬輻射劑量。ERMP 的熱釋光劑量計網絡包括二十七個位於香港各區的固定監測點(圖 2)。這個網絡使用 Harshaw 8807 型號的氟化鋰(LiF:Mg,Ti)及氟化鈣(CaF₂:Dy)熱釋光劑量計。為確保數據的統計精確度，每個監測點均設有一組共五個劑量計。每隔三個月更換及取讀熱釋光劑量計一次。

2.1.3 空中輻射監測系統

香港天文台的空中輻射監測系統於一九九八年開始運

作。這系統設有兩組碘化鈉(NaI)探測器，可安裝在政府飛行服務隊的直升機上，以進行測量。它能以輻射煙羽追蹤模式來測定香港上空有否出現輻射煙羽及鑑定其影響範圍。當輻射煙羽經過本港後，該系統也可以轉為地面輻射污染測量模式運作，判別受輻射沉降物污染的地區。進行監測時，該系統可在直升機上即時顯示伽馬圖譜、譜法分析結果及探測位置等資料，並會定時將資料備份。

2.1.4 自動伽馬譜法系統

自一九九六年起，香港天文台在大鵬灣平洲上設置了一套自動伽馬譜法系統(圖 1)，以便能儘早監測到核電站可能排放的人工放射性核素。該系統由一個鍍硫化鋅(ZnS)塑膠閃爍器、一個高純度鍍探測器和一個碘化鈉探測器組成。這系統分別利用一個迴轉空氣濾紙鼓和一個碳濾盒不斷地收集大氣飄塵及氣態碘。在空氣濾紙鼓上面的硫化鋅閃爍器測量大氣飄塵中的總阿爾法及貝他活度；在空氣濾紙鼓內的鍍探測器利用伽馬譜法，自動分析大氣飄塵釋出的伽馬射線；碘化鈉探測器則量度每週自動更換的碳濾盒中的碘-131 濃度。阿爾法和貝他的活度、碘-131 的活度及伽馬譜法分析結果等數據會每五至十五分鐘傳送至天文台總部的一個中央工作站。

2.1.5 流動輻射監測站

流動輻射監測站為一設有多款便攜式及特別設計的測量儀器的輻射勘測車輛，用作常規及應急輻射測量。車頂外置有伽馬探測器和氣管入口，利用這些裝設，測量隊員可無需離開車廂便能測量車輛外的環境伽馬輻射水平及收取空氣樣本，工作人員的安全因此而進一步受到保障。

2.1.6 高空輻射探測

天文台利用氣球攜帶 Vaisala RS92 型號探空儀及附載的輻射探測組件進行高空輻射探測工作。每個輻射探測組件(Vaisala NSS921 型號)含有兩支蓋革彌勒(Geiger Müller)管，一

支是只量度伽馬輻射的伽馬管，另一支則是量度伽馬及高於 0.25 兆電子伏(MeV)之貝他輻射的伽馬及貝他管。輻射探空儀傳回地面的數據經地面站的一台高空探測系統接收和處理。

2.2 食物及環境樣本取樣安排

2.2.1 大氣樣本

環境輻射監測計劃所收集的大氣樣本包括大氣飄塵、濕沉積物(降雨)、總沉積物(濕沉積物加上乾沉積物)、氣態碘及水蒸氣。大氣飄塵和濕沉積物樣本在京士柏、沙頭角和元五墳(圖 2)每週定期收集一次。此外，在其他七個輻射監測站亦裝置有儀器，以便在應急時收集大氣樣本。

大氣飄塵是透過高容量空氣取樣器(Hi-Q Environmental Products 4200 AFC-BRL-KIT/230 型號、Hi-Q Environmental Products BRL-3000M 型號及 Environmental TISCH TE-300-310-BL 型號)內的濾紙收集。濕沉積物則由頂部設有漏斗的容器收集。在乾燥季節期內各收集點都會放置三個漏斗容器，以收集足夠雨水作測量。

天文台亦在京士柏收集總沉積物、氣態碘及水蒸氣樣本。總沉積物的取樣器是一個盛有蒸餾水的不銹鋼圓盆，樣本每週收集一次。氣態碘樣本是利用裝有浸滲銀沸石濾盒的放射性碘取樣器(Hi-Q Environmental Products CMP-0523CV/230 型號)收集的，濾盒每週收集和更換一次。

至於水蒸氣樣本，則採用裝有燥石膏濾盒的氣態流出物取樣器(Pylon Electronics Inc. VFP-20 型號)收集。取樣器在每曆月內隨機選擇一個星期間歇地收集樣本，直至取樣總時數達三十六小時為止。

2.2.2 食物樣本

香港天文台從主要食物分銷點、批發市場和供應商收集各類市民日常食用的陸生和水生食物樣本，並特別著眼於本港和深圳出產的食物。

表 2 列載了二零一零年收集到的食物樣本。

2.2.3 飲用水、地下水及海水

經處理飲用水的樣本，是從九龍和屯門的配水管，以及沙田、屯門和油柑頭的濾水廠(圖 2)收集的。未經處理的飲用水，則從萬宜水庫、船灣淡水湖、木湖 B 抽水站，以及沙田、屯門和油柑頭(圖 2) 的濾水廠收集。水務署的職員每三個月抽取飲用水樣本一次，交香港天文台測量。

在房屋署職員、屋邨管理員及寺院人員等協助下，天文台於以下六個地點(圖 2)抽取地下水樣本：長康邨(青衣)、鈞樂新村(元朗)、環翠邨(港島東)、華富邨(薄扶林)、富山邨(東九龍)及清涼法苑(屯門)。

天文台每年均會抽取海水樣本一次。取樣地點共有四個(圖2)，均位於香港東部沿岸，分別為橫瀾島、火石洲、大浪灣及赤洲附近的海域。在環境保護署協助下，在各位置取樣時會從三個不同深度抽取海水：上層(水面下2.5米)、中層(與水面及海床等距)和低層(海床上2.5米)。海水中的懸浮粒子樣本由薄膜過濾海水樣本收集。

2.2.4 土壤及沉澱物樣本

天文台在香港境內三十九個指定地點抽取土壤樣本，每一地點取樣周期為五年。在二零一零年，天文台分別於京士柏、沙田、西貢、清水灣、萬宜水庫西、萬宜水庫東、北潭凹及白沙澳(圖 2)等地點取得土壤樣本。每個地點抽取的土壤樣本均來自兩個不同的深度：上層由地面至 15 厘米深，下

層則由 15 至 30 厘米深。

潮間帶土樣本每季在白沙灣、尖鼻咀和沙頭角三處沿岸地區(圖 2)收集。在每個取樣點均抽取兩個不同深度層的樣本，上層從表面至 15 厘米深，下層則自 15 至 30 厘米深。另外，土木工程拓展署每年在本港沿岸海域的大灘海、龍蝦灣、索罟灣，以及西區碇泊處四個地點(圖 2)協助收取海床沉澱物樣本。

2.3 食物及環境樣本的實驗室測量

食物及環境樣本的所有放射性分析均於京士柏的輻射測量室進行。表 1 列出常規監測的主要人工放射性核素。每個樣本按照不同樣本類別及測量目的，經過下列一項或多項程序分析：

- (a) 以伽馬譜法測量伽馬放射性核素的活度；
- (b) 以液體閃爍計數法測量氫⁺的放射性活度；
- (c) 以低本底總貝他計數法測量銨-90 的放射性活度；及
- (d) 以阿爾法譜法測量釷-239 的放射性活度。

有關各種量度參數的概要，例如樣本大小、量度時間及探測下限等，載列於表 3。

[⁺氫主要是在宇宙射線進入大氣層時自然地形成，或在一九四五至一九八零年間大氣核武試驗中產生，而少量亦可來自核電站運作 (UNSCEAR 2000) 。]

2.4 本底輻射監測計劃(BRMP)及環境輻射監測計劃(ERMP)的測量值比較

在 2.1 至 2.3 節所敘述的輻射測量中，環境伽馬輻射監測網絡、自動伽馬譜法系統及部分環境樣本的輻射測量在 BRMP 的期間尚未開始運作，所以本報告中有關這些系統或

樣本的輻射測量結果並沒有相應的 BRMP 範圍作本底輻射比對。

雖然如此，由於自一九九二年 ERMP 開始運作以來，其他在 BRMP 已包含的輻射測量項目的測量值均顯示香港的環境輻射水平及樣本中的人工放射性核素活度沒有超出 BRMP 範圍，顯示香港整體的環境輻射水平並沒有因核電廠的運作而產生實質的變化。故此，本報告中凡沒有 BRMP 範圍的測量值即以該項測量的首五年測量值變化範圍作參考。此參考範圍值既與 BRMP 在時間上最接近，亦同樣是為期五年，可視為該測量項目的本底數值範圍。

2.5 質量保證

自一九八九年開始，天文台已參與國際及中國內地機構舉辦的測量比對及能力測試(許建忠等，2007)，當中包括國際原子能機構(IAEA)、英國國家物理實驗室(NPL)、世界衛生組織(WHO)及中國輻射防護研究院(CIRP)。除參加測量比對及能力測試外，天文台亦透過內部質量保證程序，確保香港環境輻射監測結果的質量。

為了提升輻射測量工作的管理效能及品質，天文台輻射測量室的工作程序是依據國際標準化組織所訂下的 ISO 9001:2008 標準，以確保輻射測量服務的水平。於二零零九年初天文台的輻射測量服務成功獲得 ISO 9001:2008 認證。

其後認證機構將每年對輻射測量室作一次跟進審查，核實其輻射測量服務可繼續獲得 ISO 9001:2008 認證。天文台輻射測量室於二零一零年一月順利通過第一次年度審查，標誌著輻射測量室提供的優質輻射測量服務再一次得到認可。

3. 測量結果及結論

3.1 測量結果

3.1.1 輻射監測網絡

輻射監測網絡於二零一零年所錄得的年平均環境伽馬劑量率及一分鐘平均數據的變幅均載於表 4。測量結果均在本底輻射範圍之內。

自輻射監測網絡運作以來，各監測站錄得的輻射水平一般會隨著季節轉變而出現數個百分點的變化。在下雨或當熱帶氣旋影響香港的情況下，變化會明顯較大，甚至高於正常水平的一倍。

二零一零年環境伽馬劑量率的最大變幅於五月三十日錄得。當日香港受到一道低壓槽相關的大雨影響，在元五墳錄得的一分鐘平均劑量率較該年的平均值高出約一點二倍，但仍在本底輻射範圍之內。

3.1.2 熱釋光劑量計網絡

二零一零年各熱釋光劑量計站錄得的伽馬輻射劑量率的年平均、標準差及變幅均載於表 4。所有監測站錄得的劑量率均在 BRMP 範圍之內。

3.1.3 空中輻射監測系統

在二零一零年八月，天文台使用空中輻射監測系統在大鵬灣及西貢地區以輻射煙羽追蹤模式進行測量。直升機由海拔約一百米升至約一千米，測量海面及地面上的輻射水平隨高度的變化。測量過程中並無探測到人工放射性核素。圖 3 及圖 4 分別表示在大鵬灣和西貢地區所錄得的垂直輻射水平分佈數據。顯示一如以往觀測所得，在海面上所量度到的

計數率在垂直方向並沒有明顯變化，基本上為本底輻射水平。而在陸地上所量度到的計數率則明顯比海面上的水平高，同時亦隨高度迅速遞減，直至達到在海面上所量度到的水平。這現象主要是由於陸上產生的伽馬射線在大氣低層衰減所致。

在十月，空中輻射監測系統以地面輻射污染測量模式為吉澳進行本底輻射測量，測量高度按地勢而改變，並保持着距離地面約一百米。測量過程中並無探測到人工放射性核素，測量結果與以往相若。圖 5 為測量當天該區的鉀-40 放射性水平。

3.1.4 自動伽馬譜法系統

二零一零年自動伽馬譜法系統錄得的數據載於表5。全年並無探測到人工放射性核素，而所有測量結果均在本底輻射範圍內。

3.1.5 流動輻射監測

在二零一零年，天文台在船灣淡水湖共進行了四次宇宙輻射測量，平均伽馬劑量率為每小時 0.030 至 0.039 微戈(見表6)，與往年所得的數據相近。

3.1.6 高空輻射探測

天文台在二零一零年共進行了四次高空輻射探測。進行探測時的天氣情況如下：三月四日多雲，地面吹輕微東至東南風。七月八日天晴，地面吹輕微西風。九月二日多雲，地面吹輕微西風。十二月二日天晴，地面吹輕微西風。圖 6 顯示二零一零年四次高空輻射探測的平均大氣放射性垂直廓線，數據分析結果顯示，與以往結果大致相若(李新偉等，2007)。

3.1.7 食物及環境樣本

在二零一零年，天文台共收集了三百九十個食物及環境

樣本。表 7、8、9、10 分別顯示及列載樣本的伽馬譜法分析、氫、鋨-90 及鈾-239 的可測量活度之測量結果。表中只列出有關人工放射性核素的測量結果。為方便參考，表 11 按不同的照射途徑臚列了二零一零年各主要樣本類別的測量結果。

(a) 伽馬譜法分析

在部份二零一零年的食物、土壤及沉澱物樣本中發現微量的人工伽馬放射性核素鈾-137。這些樣本包括海產、土壤、潮間帶土及海床沉澱物。這些樣本中鈾-137 的活度均在 BRMP 相應範圍之內。

在 BRMP 及至目前的 ERMP 期間亦曾在上述樣本中發現鈾-137 (黃明松等, 2003)。在這些環境及食物樣本中發現的鈾-137 相信主要是一九四五至一九八零年間大氣核武試驗的沉降物殘餘 (UNSCEAR 2000)。

(b) 氫

在部份二零一零年的大氣、水及食物樣本中發現微量的氫，這些樣本包括濕沉積物、總沉積物、地下水、海水、飲用水、樽裝水、水果、牛奶、蔬菜、家禽、肉類、海產及海藻。這些樣本中氫的活度均在本底輻射範圍之內，相信樣本中的氫主要是因宇宙射線自然產生，而小部份則是大氣核武試驗的殘餘 (UNSCEAR 2000)。

(c) 鋨-90

在部份二零一零年的大氣、食物及土壤樣本中發現微量的鋨-90，這些樣本包括大氣飄塵、濕沉積物、總沉積物、土壤、食米、牛奶、蔬菜、水果、家禽、肉類及海產。在 BRMP 及至目前的 ERMP，上述樣本中亦曾發現鋨-90。鋨-90 亦主要來自大氣核武試驗 (UNSCEAR 2000)。

這些樣本中鋨-90 的活度均在本底輻射範圍之內。

(d) 鈾-239

在部份二零一零年的沉澱物樣本中發現微量的鈾-239，這

些樣本包括潮間帶土及海床沉澱物。這些樣本中鈾-239 的活度均在 BRMP 的相應範圍之內。同樣，樣本中發現的鈾-239 主要來自大氣核武試驗的沉降物（UNSCEAR 2000）。

總括來說，二零一零年所有食物及環境樣本中人工放射性核素的活度均在本底輻射範圍之內。

3.2 結論

二零一零年在香港境內不同地點錄得的環境伽馬劑量率均在本底輻射範圍之內。與過去的情況相若，天文台在不同的環境及食物樣本中測量到微量的人工放射性核素，包括銫-137、氙、鋨-90 及鈾-239。它們的水平與在廣東核電站及嶺澳核電站運作之前所收集的樣本並沒有顯著分別。

以此總結，二零一零年香港的環境輻射水平及在環境和食物樣本中的人工放射性核素活度並沒有可測量到的變化。

鳴謝

謹此感謝漁農自然護理署、土木工程拓展署、環境保護署、水務署及房屋署協助收集樣本，政府化驗所製備樣本，衛生署提供熱釋光劑量計和讀取相應數據，政府飛行服務隊配合天文台運作空中輻射監測系統和香港警務處在其轄下警署提供地方，裝設輻射監測站和自動伽馬譜法系統。我們亦衷心感謝多個機構團體，容許香港天文台在其場地內安裝熱釋光劑量計和收集樣本。

參考文獻

1. Hong Kong Observatory (香港天文台) 1992 Environmental Radiation Monitoring in Hong Kong, Technical Report No. 8: Background Radiation Monitoring Programme 1987-1991.
2. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2000 Sources and Effects of Ionizing Radiation, Volume I: Sources.
3. Wong, M.C., H.T. Poon, H.Y. Mok and Y.S. Li (黃明松, 潘海濤, 莫慶炎及李月嬋) 2003 Environmental Radiation Monitoring in Hong Kong – 1987 to 2002, Technical Note No. 106, Hong Kong Observatory.
4. Hui, K.C., S.W. Li and K.C. Tsui (許建忠, 李新偉及徐傑志) 2007 Performance of Hong Kong Observatory in Inter-laboratory Comparison Exercises on Radioactivity Measurements 1989 to 2005, Technical Note (Local) No. 84, Hong Kong Observatory.
5. Li, S.W., Y.S. Li and K.C. Tsui (李新偉, 李月嬋及徐傑志) 2007 Radioactivity in the atmosphere over Hong Kong, Journal of Environmental Radioactivity, vol. 94, pp. 98-106.

CONTENTS

	page
FIGURES	22
TABLES	23
1. INTRODUCTION	24
2. SAMPLING, MEASUREMENT AND QUALITY ASSURANCE	25
2.1 Direct measurement of ambient radiation level	25
2.2 Collection of food and environmental samples	27
2.3 Measurement of food and environmental samples in laboratory	28
2.4 Comparison between BRMP and ERMP measurement results	29
2.5 Quality assurance	29
3. RESULTS AND CONCLUSION	31
3.1 Results	31
3.2 Conclusion	33
ACKNOWLEDGEMENT	35
REFERENCES	36

FIGURES

	page
1. Locations for real-time measurement of ambient radiation	37
2. Thermoluminescent dosimeter network and collection locations of environmental samples in 2010	38
3. Variation of count rate with altitude at Mirs Bay, as measured by the Aerial Radiation Monitoring System on 3 August 2010	39
4. Variation of count rate with altitude at Sai Kung area, as measured by the Aerial Radiation Monitoring System on 3 August 2010	40
5. Radioactivity level of Potassium-40 over Kat O, as measured by the Aerial Radiation Monitoring System at about 100 metres above the ground on 5 October 2010	41
6. Average vertical profiles of atmospheric radioactivity from four upper-air radioactivity soundings conducted in 2010 (dates of sounding: 4 March, 8 July, 2 September and 2 December)	42

TABLES

	page
1. Summary of the sampling and analysis programme	43
2. Summary of food samples	48
3. Summary of key measurement parameters	50
4. Ambient gamma dose rates recorded by the radiation monitoring network and thermoluminescent dosimeter network in 2010	52
5. Results of measurement by the Automatic Gamma Spectrometry System at Ping Chau in 2010	54
6. Measurement results of gamma dose rates due to cosmic radiation in 2010	54
7. Measurement results of measurable gamma activities of artificial gamma-emitting radionuclides in food and environmental samples in 2010	55
8. Measurement results of measurable activities of tritium in food and environmental samples in 2010	56
9. Measurement results of measurable activities of strontium-90 in food and environmental samples in 2010	60
10. Measurement results of measurable activities of plutonium-239 in food and environmental samples in 2010	62
11. Overall summary of measurement results in 2010	63

1. INTRODUCTION

Since 1961, the Hong Kong Observatory (HKO) has been monitoring environmental radiation levels in Hong Kong and participating in international programmes on environmental radiation monitoring organised by the International Atomic Energy Agency (IAEA) and the World Meteorological Organization (WMO). In response to the construction of nuclear power stations at Daya Bay in Guangdong, the HKO embarked in 1983 on a comprehensive program to monitor the environmental radiation levels in Hong Kong before and after the power plants commenced operation.

The radiation monitoring program consists of two phases. The first phase is known as the Background Radiation Monitoring Programme (BRMP) and was conducted in the 5-year period from 1987 to 1991 to establish the baseline radiation levels in Hong Kong prior to the operation of the Guangdong Nuclear Power Station (GNPS) in 1994 (see Figure 1 for location). These baseline levels would enable the detection of changes arising from the operation of GNPS if any. The monitoring results for the years from 1987 to 1991 can be found in the report on the BRMP (HKO 1992). The second phase of the monitoring program is known as the Environmental Radiation Monitoring Programme (ERMP), which commenced in 1992 and contains all the essential features of the BRMP but with adjustments in sampling and measurement to take advantage of the experience gained. The ERMP is an on-going programme to determine long-term changes in environmental radiation levels in Hong Kong if any, particularly those arising from the operation of the GNPS and the Lingao Nuclear Power Station (LNPS) since 1994 and 2002 respectively.

The monitoring results of the years from 1992 to 2002 can be found in the respective annual reports (<http://www.weather.gov.hk/publica/pubrm.htm>). From 2003, the annual report only includes the most salient features of the programme, including summaries of measurement methods and results, highlights of new work, changes and measures introduced during the year. Readers may refer to the previous reports for details of the sampling, measurement and quality assurance work.

Chapter 2 in this report describes the sampling schedule, the instruments and methods used for measuring ambient radiation levels, as well as radioactivity in food and environmental samples. A summary of the quality assurance system is also given. Measurement results and conclusion are presented in Chapter 3.

2. SAMPLING, MEASUREMENT AND QUALITY ASSURANCE

The emphasis of the Environmental Radiation Monitoring Programme is to monitor three major exposure pathways, namely the atmospheric pathway, the terrestrial pathway and the aquatic pathway. In respect of measurement, there are two major components. The first component is the direct measurement of ambient radiation levels in Hong Kong. The second is the detection of any artificial radioactive material, arising from the operation of GNPS and LNPS, in the environment of Hong Kong and in the foodstuff commonly consumed by Hong Kong people. The locations for real-time measurement of ambient radiation are shown in Figure 1. The other locations for measurement of ambient gamma radiation and collection of environmental samples in 2010 are shown in Figure 2. A summary of the sampling and analysis programmes of the ERMP in 2010 is given in Table 1.

2.1 Direct measurement of ambient radiation level

2.1.1 *Radiation Monitoring Network*

Since the commencement of the ERMP, the ambient gamma dose rates have been monitored by a radiation monitoring network (RMN) consisting of 10 fixed stations (Figure 1). The dose rates are measured at each station continuously by a high pressure ionization chamber (HPIC) (Reuter-Stokes Model RSS-131 environmental radiation monitor). Data are transmitted to the Observatory Headquarters once every minute.

2.1.2 *Thermoluminescent Dosimeter Network*

A thermoluminescent dosimeter (TLD) network has been in operation since the late 1980s to measure ambient gamma doses accumulated over a long period. In ERMP, the network comprises 27 monitoring points over the territory (Figure 2). The TLDs are of the lithium fluoride (LiF:Mg,Ti) and calcium fluoride (CaF₂:Dy) type (Harshaw Type 8807). A batch of five TLDs is placed at each site to ensure statistical accuracy. The TLDs are replaced and read once every quarter.

2.1.3 *Aerial Radiation Monitoring System*

The Aerial Radiation Monitoring System has been put into operation since 1998. The system consists of two assemblies of sodium iodide (NaI) detectors that can be mounted on board a helicopter of the Government Flying Service when in operation. When operating in the plume tracking mode, it has the capability to determine the existence and extent of any radioactive plume over Hong Kong. After passage of the plume, the system using the ground contamination measurement mode can be used to identify surface areas contaminated by deposited radionuclides. Gamma spectra,

spectroscopic analysis results and location information are displayed on board the helicopter in real time and archived at regular intervals.

2.1.4 Automatic Gamma Spectrometry System

Hong Kong Observatory has been operating the Automatic Gamma Spectrometry System (AGSS) at Ping Chau, Mirs Bay since 1996 (Figure 1) for providing early alert to any releases of artificial radionuclides from the nuclear power stations. The system consists of a zinc sulphide (ZnS) coated plastic scintillator, a high purity germanium detector and a NaI detector. It continuously collects airborne particulates on a rotating filter drum and gaseous iodine in a carbon cartridge. The ZnS scintillator directly above the filter drum measures the gross alpha and beta activities of the particulates collected. Inside the filter drum, the germanium detector measures gamma rays emitted by the particulates and gamma spectrometry analysis is carried out automatically. The NaI detector measures the iodine-131 concentration in the carbon cartridge which is replaced automatically at weekly intervals. Data of alpha and beta activities, iodine-131 activity, as well as results of gamma spectrometry analysis are transmitted to a central station at the Observatory Headquarters every 5 to 15 minutes.

2.1.5 Mobile Radiation Monitoring Station

The Mobile Radiation Monitoring Station (MRMS) is a radiological survey vehicle that is equipped with portable and specially designed instruments for use in routine and emergency radiological surveys. An external gamma probe and an air inlet on the vehicle roof provide the means to measure the ambient gamma radiation levels outside the vehicle and to collect air samples without the survey team members having to leave the vehicle. This further enhances personnel safety during radiological surveys.

2.1.6 Upper-air Radioactivity Soundings

Radioactivity in the upper atmosphere is measured by radioactivity sensors attached to balloon-borne radiosondes (Vaisala Model RS92). The radioactivity sensor (Vaisala Model NSS921) comprises of two Geiger-Müller (GM) tubes, the gamma-only tube, which measures only gamma radiation, and the gamma-plus-beta tube, which measures gamma radiation as well as beta radiation of energies higher than 0.25 MeV. Data from the radioactivity sensor is transmitted back and processed via the upper-air sounding system at the ground station.

2.2 Collection of food and environmental samples

2.2.1 *Atmospheric Samples*

Atmospheric samples, including airborne particulates, wet deposition (precipitation), total deposition (wet plus dry deposition), gaseous iodine and water vapour, are collected under the Environmental Radiation Monitoring Programme. Airborne particulates and wet deposition are regularly collected at King's Park, Sha Tau Kok and Yuen Ng Fan (Figure 2) at weekly intervals. In addition, equipment is also installed at the other seven radiation monitoring stations for collecting atmospheric samples during emergency.

Airborne particulates are collected from a filter paper installed inside a high volume air sampler (Hi-Q Environmental Products Model 4200 AFC-BRL-KIT/230, Hi-Q Environmental Products Model BRL-3000M and Environmental TISCH Model TE-300-310-BL). Wet deposition is collected by a carboy fitted with a top funnel. During the dry season, three sets of carboys and funnels are used at each location for collection of sufficient amount of rain for measurement.

Total deposition, gaseous iodine and water vapour are also collected at King's Park. The sampler for total deposition is a stainless-steel pan partially filled with distilled water to collect samples at weekly intervals. Gaseous iodine is sampled through a silver impregnated zeolite cartridge fitted inside a radioiodine sampler (Hi-Q Environmental Products Model CMP-0523CV/230) and is collected and replaced weekly.

Water vapour is collected using a gaseous effluent sampler (Pylon Electronics Inc. Model VFP-20) with a drierite cartridge operated intermittently for a total collection time of 36 hours within a randomly selected week within each calendar month.

2.2.2 *Food Samples*

Both terrestrial and aquatic foodstuffs typical of the diet of the local population are collected at main distribution points, wholesale markets and from enlisted suppliers. Particular attention has been given to food produced locally and in Shenzhen.

Food samples collected in 2010 are listed in Table 2.

2.2.3 *Drinking Water, Underground Water and Sea Water*

Treated drinking water is collected from distribution taps at Kowloon and Tuen Mun as well as the treatment works at Shatin, Tuen Mun and Yau Kom Tau (Figure 2).

Untreated or raw drinking water is collected from the High Island Reservoir, the Plover Cove Reservoir, the Muk Wu B Pumping Station and the treatment works at Shatin, Tuen Mun and Yau Kom Tau (Figure 2). Both treated and untreated drinking water are collected once every three months by staff of the Water Supplies Department.

Underground water is collected at six locations (Figure 2), namely Cheung Hong Estate (Tsing Yi), Kwan Lok San Tsuen (Yuen Long), Wan Tsui Estate (East Hong Kong Island), Wah Fu Estate (Pokfulam), Fu Shan Estate (East Kowloon) and Ching Leung Nunnery (Tuen Mun) with assistance from the Housing Department, the respective estate management and the nunnery personnel.

Sea water is sampled annually at four locations in the eastern part of the coastal waters of Hong Kong (Figure 2), namely waters off Waglan Island, Basalt Island, Tai Long Wan and Port Island. At each location, samples are collected at three depths - the upper level (2.5 metres underneath the surface), the middle level (equidistant from the surface and the seabed), the lower level (2.5 metres above the seabed) with the assistance of the Environmental Protection Department. Suspended particulates in sea water are collected by filtering the sea water samples through a membrane filter.

2.2.4 Land Soil and Sediments

Land soil is sampled at 39 designated sites throughout the territory. Each site is sampled once every 5 years. In 2010, land soil samples were collected from King's Park, Sha Tin, Sai Kung, Clear Water Bay, High Island West, High Island East, Pak Tam Au and Pak Sha O (Figure 2). At each site, samples were collected from two layers, the upper layer from the surface to 15 cm deep and the lower layer from 15 cm to 30 cm deep.

Intertidal sediments are sampled quarterly at three locations along the coast of Hong Kong (Figure 2), namely Pak Sha Wan, Tsim Bei Tsui and Sha Tau Kok. Two layers are taken at each sampling point, the upper layer from the surface to 15 cm deep and the lower layer from 15 cm to 30 cm deep. Sampling of seabed sediments is carried out annually with the assistance of the Civil Engineering and Development Department at four locations in the coastal waters of Hong Kong (Figure 2), namely, Tai Tan Hoi, Lung Ha Wan, Picnic Bay and Western Anchorage.

2.3 Measurement of food and environmental samples in laboratory

All radioactivity measurements of food and environmental samples are carried out at the Radiation Laboratory at King's Park. A list of the major artificial radionuclides routinely monitored in the Environmental Radiation Monitoring Programme is given in Table 1. Each sample, depending on the sample type and

measurement objective, would go through one or more of the following analyses:

- (a) gamma spectrometry analysis to determine the activities of gamma-emitting radionuclides;
- (b) liquid scintillation counting to determine the activity of tritium[†];
- (c) low-level gross beta counting to determine the activity of strontium-90; and
- (d) alpha spectrometry analysis to determine the activity of plutonium-239.

A summary of key measurement parameters, including sample size, counting time and detection limits, are given in Table 3.

[[†]Tritium is primarily produced naturally by cosmic rays entering the atmosphere or generated during atmospheric nuclear tests conducted from 1945 until 1980. A small amount is also produced during operation of nuclear power stations. (UNSCEAR 2000)]

2.4 Comparison between BRMP and ERMP measurement results

Among the radiation measurements described in Section 2.1 to 2.3, the Radiation Monitoring Network, Automatic Gamma Spectrometry System as well as radiological measurements of some of the environmental samples had not yet started operation during the BRMP period. Hence for the measurement results from these systems or samples, no corresponding BRMP ranges are available for the purpose of background reference.

However, since start of ERMP in 1992, results of all BRMP-covered radiation measurements reveal that the ambient radiation levels and activities of artificial radionuclides all fall within BRMP ranges. This implies that no material changes in the overall environmental radiation levels in Hong Kong as a result of the operation of the nuclear power plants are detected. For this reason, for radiation measurements without BRMP reference values, the range of values in the first 5 years of measurement will be adopted as the reference range of that measurement in this report. This reference range, being closest to BRMP period in time and spanning the same 5-year period, can effectively be taken as the baseline level of that radiation measurement.

2.5 Quality assurance

Since 1989, the Observatory has been participating in inter-laboratory comparison exercises and proficiency tests organized by major international and national organizations (Hui *et al.*, 2007), namely the International Atomic Energy Agency (IAEA), the National Physical Laboratory of the United Kingdom (NPL), the

World Health Organization (WHO), the China Institution for Radiation Protection (CIRP). Other than inter-laboratory comparison exercises and proficiency tests, the quality of the environmental radiation monitoring results in Hong Kong is also assured through internal quality assurance procedures.

In order to enhance the management efficiency and quality of its radiation measurement work, the Hong Kong Observatory Radiation Laboratory maintains a high standard of its radiation measurement services based on the International Organisation for Standardization ISO 9001:2008. Accreditation for the ISO 9001:2008 for its radiation measurement services from the international organization concerned was obtained in early 2009.

After that, the certification body will conduct annual surveillance audit of the Radiation Laboratory to ascertain that its radiation measurement services meet the requirements for continuation of the ISO 9001:2008 certification. The quality radiation measurement services provided by the Radiation Laboratory were recognized again when it successfully passed the first Annual Surveillance Audit in January 2010.

3. RESULTS AND CONCLUSION

3.1 Results

3.1.1 Radiation Monitoring Network

The annual average ambient gamma dose rates and ranges of 1-minute averages recorded by the RMN in 2010 are tabulated in Table 4. The measurement results were all within baseline radiation levels.

Since the operation of the RMN, temporal changes in the radiation level recorded at the stations are typically a few per cent in seasonal variations. However, during rainy condition or episodes of tropical cyclone affecting Hong Kong, the variations can be significantly larger and may even double the normal level.

The most significant change in the ambient gamma dose rate in 2010 was recorded on 30 May. Under the influence of heavy rain associated with a trough of low pressure, the 1-minute average dose rate at Yuen Ng Fan rose to about 1.2 times above the mean value of the year, but still within the baseline levels.

3.1.2 Thermoluminescent Dosimeter Network

The annual average, standard deviation and range of gamma dose rates measured at each of the TLD stations in 2010 are listed in Table 4. The gamma dose rates recorded at all stations were found to be within the BRMP range.

3.1.3 Aerial Radiation Monitoring System

In August 2010, measurement flights in the plume tracking mode were carried out over Mirs Bay and Sai Kung area. The helicopter rose from about 100 metres up to about 1000 metres above sea level to measure the change of radiation level against altitude over the sea surface and over the land surface. No artificial radionuclides were detected. Figure 3 and Figure 4 depict the vertical radiation level profiles over Mirs Bay and Sai Kung area respectively. The results were identical with past observations. The count rate arising from gamma rays from the sea reflects basically the background radiation level and shows no significant change with height. It is much lower than that measured over land surface. On the other hand, the count rate measured over land surface decreases rapidly with height before reaching a level close to that measured over the sea. This mainly arises from the attenuation of gamma rays emanating from the ground in the lower atmosphere.

In October, a background measurement in the ground contamination measurement mode was conducted over Kat O. The measurement height followed terrain but was maintained at a height of about 100 metres above the ground. No artificial radionuclides were detected. Figure 5 shows the radioactivity level of

potassium-40 over the area on the day of measurement. The results obtained were similar to those of past years.

3.1.4 Automatic Gamma Spectrometry System

Results obtained by the AGSS in 2010 are given in Table 5. No artificial radionuclides were detected, and all results were within baseline radiation levels.

3.1.5 Mobile Radiation Monitoring

Four measurements of cosmic radiation were carried out at Plover Cove in 2010. The average gamma dose rates ranged from 0.030 to 0.039 $\mu\text{Gy h}^{-1}$ (Table 6), close to those measured in previous years.

3.1.6 Upper-air Radioactivity Soundings

Four radioactivity soundings were made in 2010. The weather conditions during these soundings were: cloudy with light east to southeasterly winds at the surface on 4 March; fine with light westerly winds at the surface on 8 July; cloudy with light westerly winds at the surface on 2 September; fine with light westerly winds at the surface on 2 December. Figure 6 shows the average vertical profiles of atmospheric radioactivity from the four upper-air radioactivity soundings in 2010. The data analysis results obtained were similar to those of past years (Li *et al.* 2007).

3.1.7 Food and Environmental Samples

A total of 390 food and environmental samples were collected in 2010. Only the measurement results of those samples with measurable activity are presented and tabulated in Tables 7, 8, 9 and 10, showing the results of gamma spectrometry analyses, tritium measurements, strontium-90 measurements and plutonium-239 measurements respectively. Only results pertaining to artificial radionuclides are included. For ease of reference, a summary of measurement results in 2010 for the major sample types according to different pathways is given in Table 11.

(a) Gamma Spectrometry Analyses

Traces of caesium-137, an artificial gamma-emitting radionuclide, were detected in some food, soil and sediment samples in 2010, including seafood, land soil, intertidal sediment and seabed sediment. The measured activities in these samples were all within the corresponding ranges of BRMP values.

Caesium-137 was detected in the above sample types in both BRMP and the ERMP so far (Wong *et al.* 2003). The presence of the radionuclide in environmental and food samples could generally be attributed to remnants of the

fallout of atmospheric nuclear tests conducted from 1945 until 1980 (UNSCEAR 2000).

(b) Tritium

Very low amounts of tritium were detected in some atmospheric, water and food samples in 2010, including wet deposition, total deposition, underground water, sea water, drinking water, bottled water, fruits, milk, vegetables, poultry, meat, seafood and seaweed. The measured activities in these samples were all within the baseline radiation levels. As such, the source of tritium in the samples is primarily attributable to the natural cosmogenic process while a small portion was the remnant of atmospheric nuclear tests (UNSCEAR 2000).

(c) Strontium-90

Traces of strontium-90 were detected in some atmospheric, food and soil samples in 2010, including air particulates, wet deposition, total deposition, land soil, rice, milk, vegetables, fruits, poultry, meat and seafood. The radionuclide was detected in the above types of samples in both BRMP and the ERMP so far. The radionuclide's presence is also primarily attributable to atmospheric nuclear tests (UNSCEAR 2000).

The measured strontium-90 activities in these samples were within the baseline radiation levels.

(d) Plutonium-239

Minute amounts of plutonium-239 were detected in some sediment samples in 2010, including intertidal sediment and seabed sediment. The measured activities in these samples were all within the corresponding ranges of BRMP values. It is believed that fallout of atmospheric nuclear tests was again the major source of the radionuclide (UNSCEAR 2000).

To summarize, the activities of the artificial radionuclides in all the food and environmental samples collected in 2010 were found to be within the baseline radiation levels.

3.2 Conclusion

The ambient gamma dose rates recorded over various parts of the territory in 2010 were within the baseline radiation levels. As in the past years, traces of artificial radionuclides, namely caesium-137, tritium, strontium-90 and plutonium-239, were detected in various environmental and food samples. The levels of all these

radionuclides were not significantly different from those recorded before the Guangdong Nuclear Power Station and Lingao Nuclear Power Station came into operation.

It is concluded that in 2010 there was no measurable change in ambient radiation levels and in activities of artificial radionuclides in the Hong Kong environment and foodstuffs consumed by Hong Kong people.

ACKNOWLEDGEMENT

The Hong Kong Observatory wishes to express its gratitude to the Agriculture, Fisheries and Conservation Department, Civil Engineering and Development Department, Environmental Protection Department, Water Supplies Department and Housing Department for their assistance in sample collection, the Government Laboratory for chemical treatment of samples, and the Department of Health for providing and reading thermoluminescent dosimeters. We would also like to express our appreciation to the Government Flying Service for the operation of the Aerial Radiation Monitoring System, and the Hong Kong Police Force for providing accommodation at police stations to a number of radiation monitoring stations and the Automatic Gamma Spectrometry System. Special thanks also go to all organisations for which gave us permission to install thermoluminescent dosimeters and to collect samples within their premises.

REFERENCES

1. Hong Kong Observatory 1992 Environmental Radiation Monitoring in Hong Kong, Technical Report No. 8: Background Radiation Monitoring Programme 1987-1991.
2. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2000 Sources and Effects of Ionizing Radiation, Volume I: Sources.
3. Wong, M.C., H.T. Poon, H.Y. Mok and Y.S. Li 2003 Environmental Radiation Monitoring in Hong Kong – 1987 to 2002, Technical Note No. 106, Hong Kong Observatory.
4. Hui, K.C., S.W. Li and K.C. Tsui 2007 Performance of Hong Kong Observatory in Inter-laboratory Comparison Exercises on Radioactivity Measurements 1989 to 2005, Technical Note (Local) No. 84, Hong Kong Observatory.
5. Li, S.W., Y.S. Li and K.C. Tsui 2007 Radioactivity in the atmosphere over Hong Kong, Journal of Environmental Radioactivity, vol. 94, pp. 98-106.

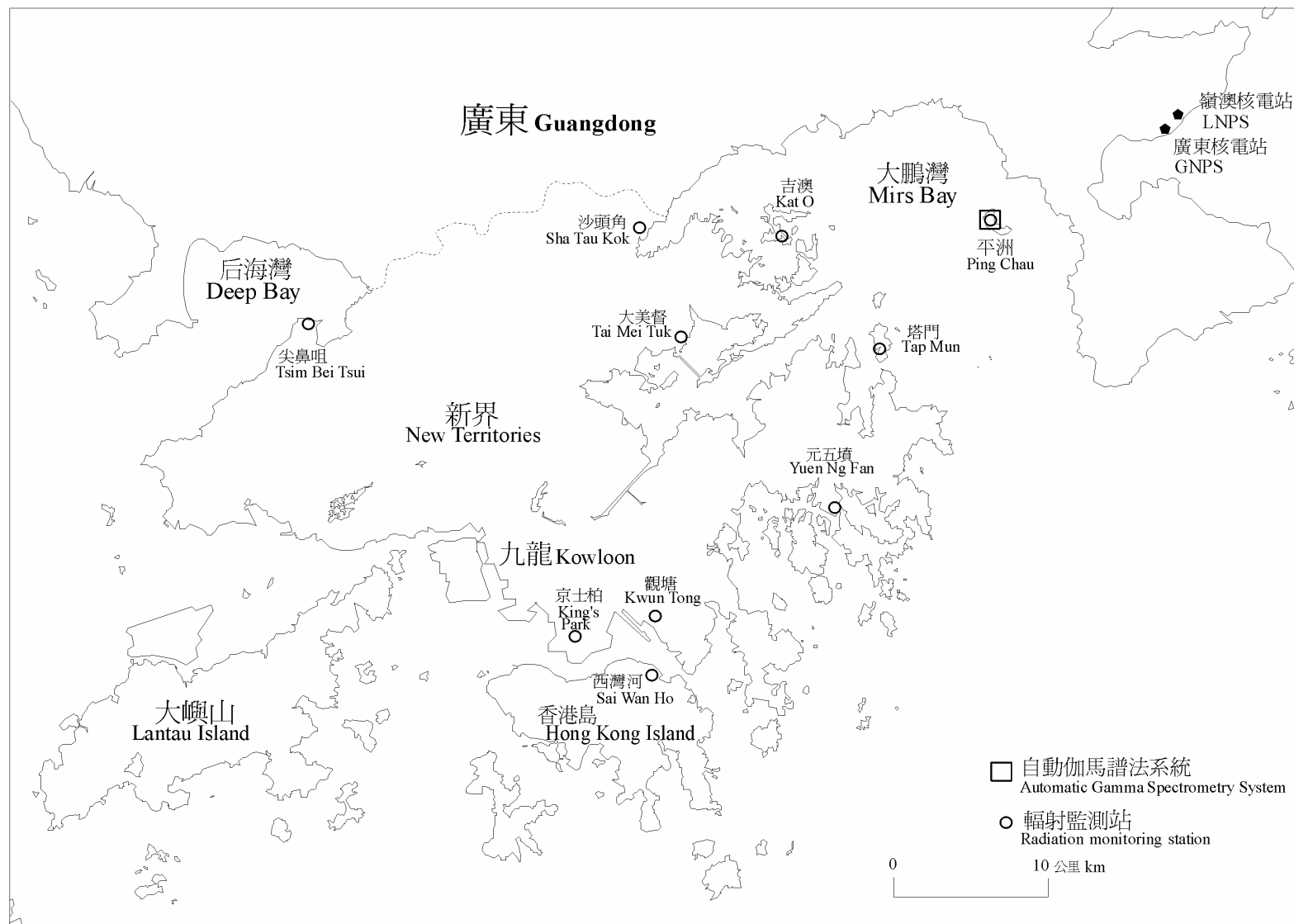


圖 1. 實時監測環境輻射的測量點。

Figure 1. Locations for real-time measurement of ambient radiation.

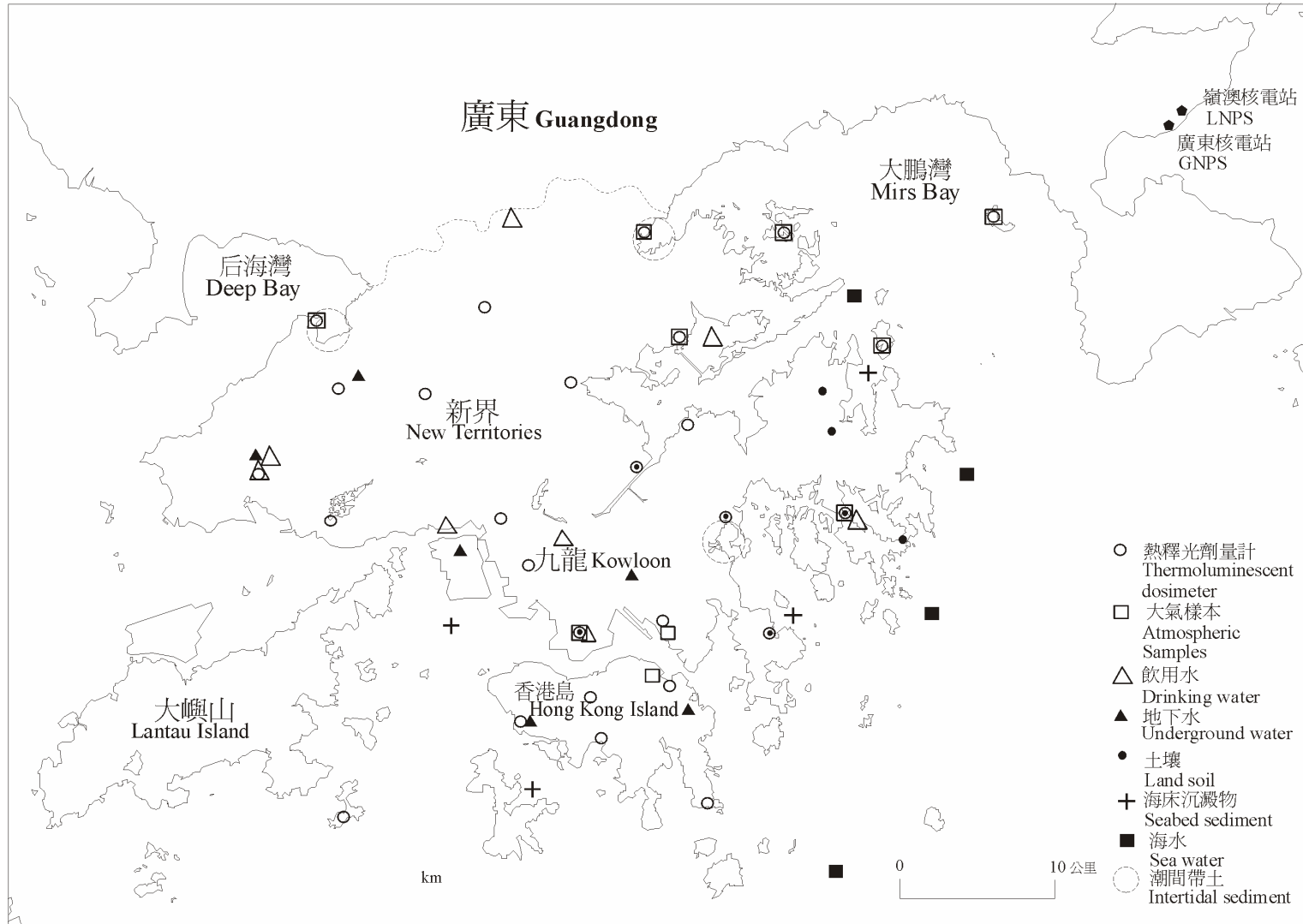


圖 2. 熱釋光劑量計網絡及二零一零年環境樣本收集點。

Figure 2. Thermoluminescent dosimeter network and collection locations of environmental samples in 2010.

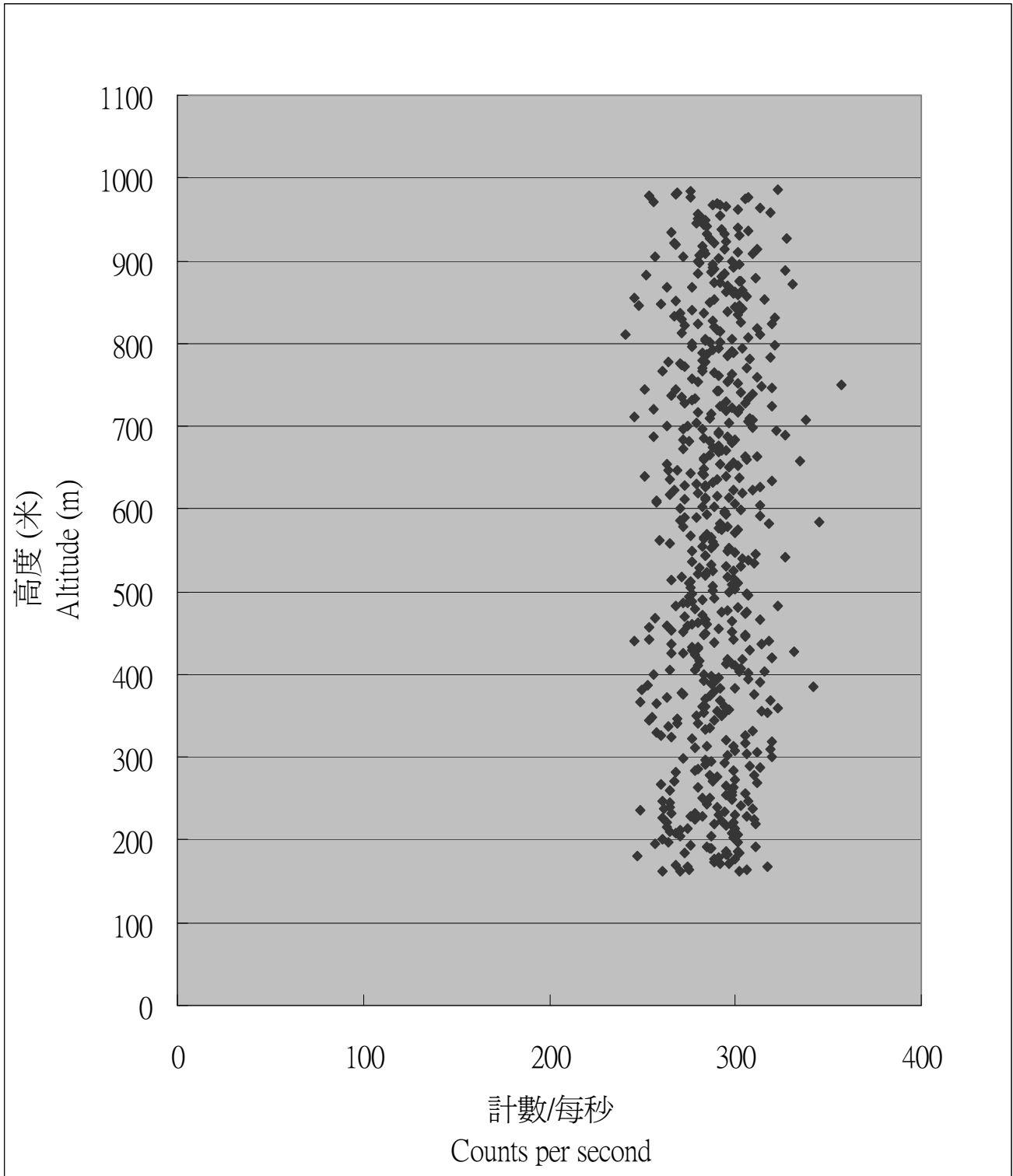


圖 3. 空中輻射監測系統在大鵬灣海面上空測量到的計數率隨高度的變化
(二零一零年八月三日)。

Figure 3. Variation of count rate with altitude at Mirs Bay, as measured
by the Aerial Radiation Monitoring System on 3 August 2010.

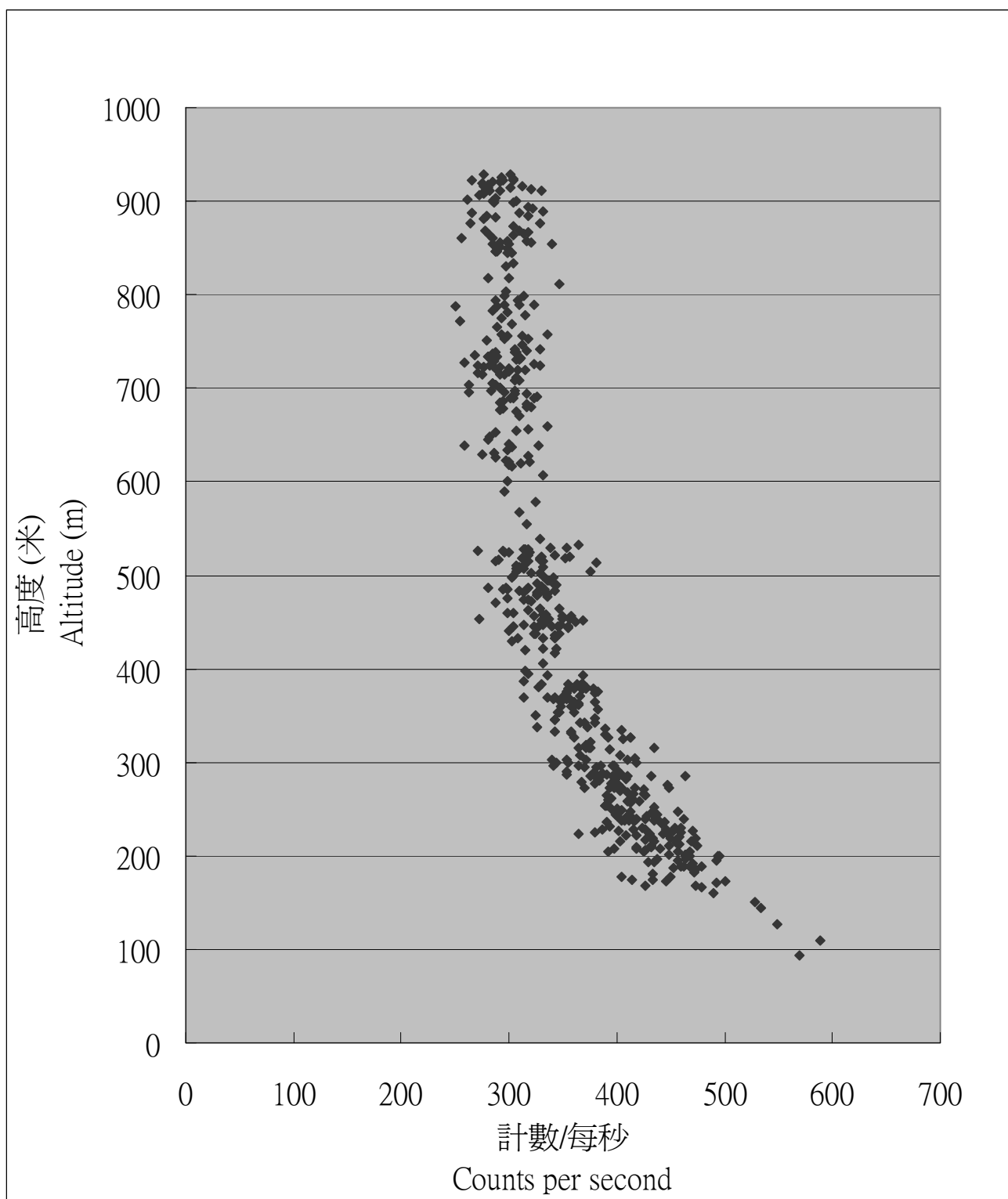


圖 4. 空中輻射監測系統在西貢地區上空測量到的計數率隨高度的變化
(二零一零年八月三日)。

Figure 4. Variation of count rate with altitude at Sai Kung area, as measured by the Aerial Radiation Monitoring System on 3 August 2010.

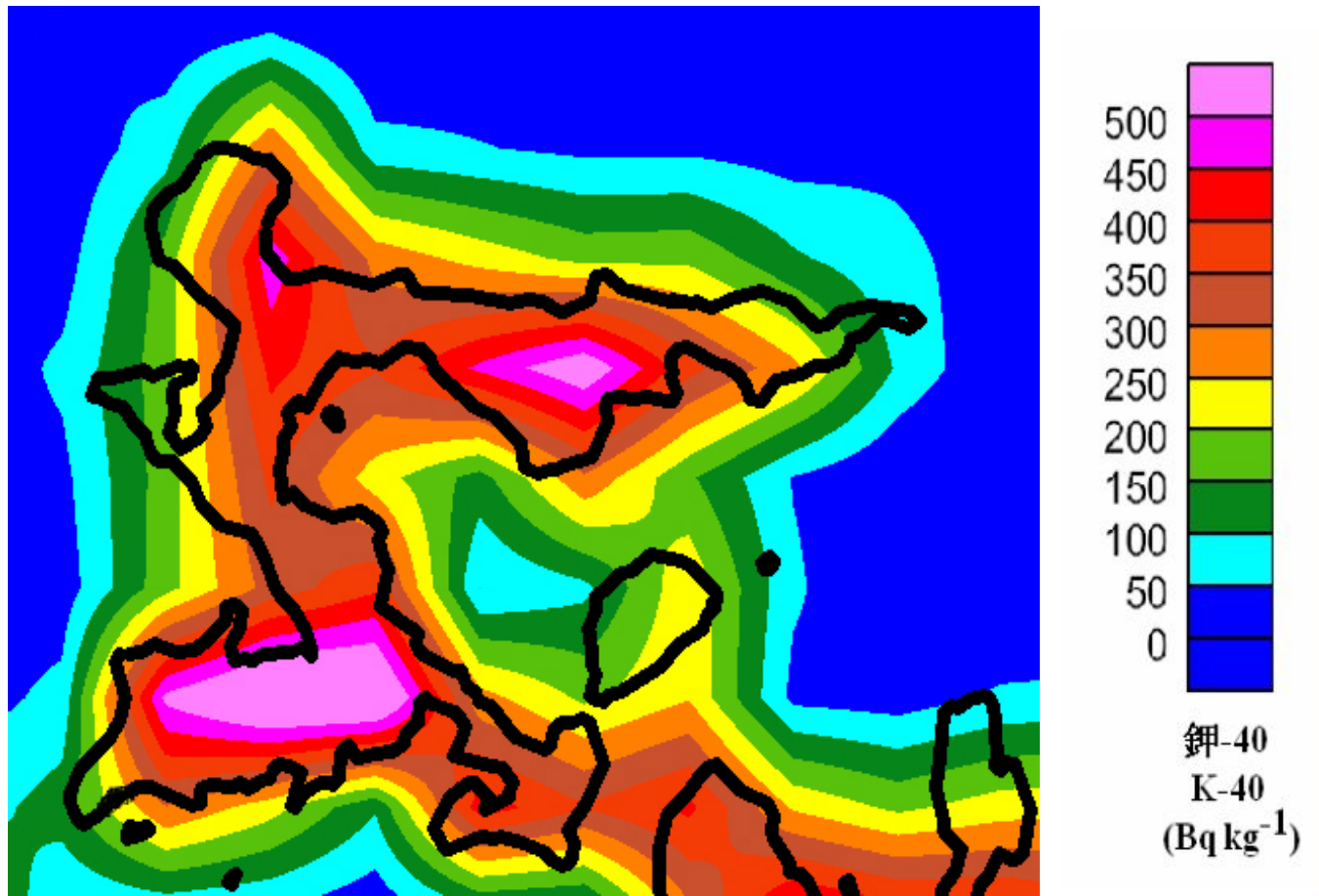


圖 5. 空中輻射監測系統在吉澳上空測量到的鉀-40 放射性水平 (測量高度距離地面約一百米)
(二零一零年十月五日)。

Figure 5. Radioactivity level of Potassium-40 over Kat O, as measured
by the Aerial Radiation Monitoring System at about 100 metres above the ground on 5 October 2010.

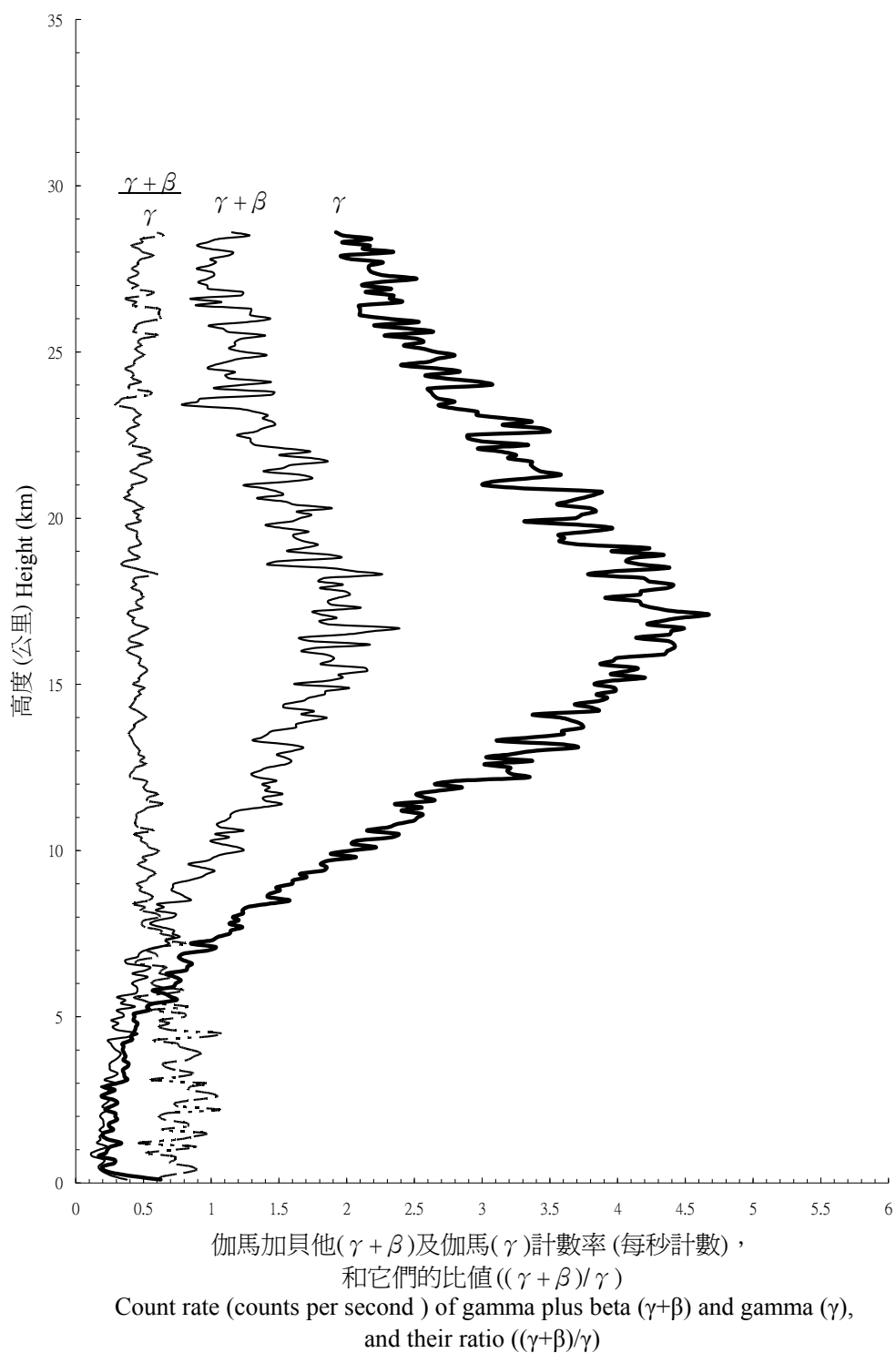


圖 6. 二零一零年內進行四次高空輻射探測的平均大氣放射性垂直廓線 (探測日期為：三月四日、七月八日、九月二日及十二月二日)。

Figure 6. Average vertical profiles of atmospheric radioactivity from four upper-air radioactivity soundings conducted in 2010 (dates of sounding: 4 March, 8 July, 2 September and 2 December).

表 1. 樣本取樣及分析概要

Table 1. Summary of the sampling and analysis programme

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
環境伽馬輻射 Ambient Gamma Radiation				
伽馬劑量率 Gamma dose rates	平洲 Ping Chau, 塔門 Tap Mun, 吉澳 Kat O, 沙頭角 Sha Tau Kok, 元五墳 Yuen Ng Fan, 大美督 Tai Mei Tuk, 尖鼻咀 Tsim Bei Tsui, 觀塘 Kwun Tong, 西灣河 Sai Wan Ho, 京士柏 King's Park	10	伽馬 γ	一分鐘 1-minute interval
累積伽馬劑量 Cumulative gamma doses	平洲 Ping Chau, 塔門 Tap Mun, 吉澳 Kat O, 元五墳 Yuen Ng Fan, 清水灣 Clear Water Bay, 西貢 Sai Kung, 大美督 Tai Mei Tuk, 烏溪沙 Wu Kai Sha, 鶴咀 Cape D'Aguilar, 沙頭角 Sha Tau Kok, 沙田 Shatin, 觀塘 Kwun Tong, 筲箕灣 Shau Kei Wan, 大埔 Tai Po, 京士柏 King's Park, 跑馬地 Happy Valley, 深水灣 Deep Water Bay, 石梨貝 Shek Lei Pui, 置富花園 Chi Fu Fa Yuen, 粉嶺 Fanling, 荃灣 Tsuen Wan, 石崗 Shek Kong, 長洲 Cheung Chau, 元朗 Yuen Long, 大欖涌 Tai Lam Chung, 尖鼻咀 Tsim Bei Tsui, 屯門 Tuen Mun	27	伽馬 γ	每季 quarterly
大氣樣本 Atmospheric Samples				
大氣飄塵 Airborne particulate	京士柏 King's Park, 沙頭角 Sha Tau Kok, 元五墳 Yuen Ng Fan	3	伽馬 γ , 銨-90 Sr-90, 釷-239 Pu-239	每週 (累積一月) weekly (bulked monthly)
濕沉積物(降雨) Wet deposition (precipitation)	京士柏 King's Park, 沙頭角 Sha Tau Kok, 元五墳 Yuen Ng Fan	3	伽馬 γ , 氬 H-3, 銨-90 Sr-90, 釷-239 Pu-239	每週 (累積一月) weekly (bulked monthly)
總沉積物 Total deposition	京士柏 King's Park	1	伽馬 γ , 氬 H-3, 銨-90 Sr-90, 釷-239 Pu-239	每週 (累積一月) weekly (bulked monthly)
氣態碘 Airborne radioiodine	京士柏 King's Park	1	伽馬 γ	每週 weekly
大氣水蒸氣 Water vapour in air	京士柏 King's Park	1	氬 H-3	每月 monthly

表 1. (續)
Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
地面樣本 Terrestrial Samples				
食米 Rice	內地 Mainland	1	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen, 沙頭角 Sha Tau Kok	2	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly
菜心 Choi sum	內地 Mainland, 本地 Local	2	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly
白菜 Pak choi	內地 Mainland, 本地 Local	2	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly
香蕉 Banana	內地 Mainland	1	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly
荔枝 Lychee	內地 Mainland	1	伽馬 γ , 氫 H-3, 銨-90 Sr-90	夏季 summer
柑橘 Mandarin	內地 Mainland	1	伽馬 γ , 氫 H-3, 銨-90 Sr-90	秋季及冬季 autumn and winter
甘蔗 Sugar cane	內地 Mainland	1	伽馬 γ , 氫 H-3, 銨-90 Sr-90	春季 spring
雞 Chicken	內地 Mainland, 本地 Local	2	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly
鴨 Duck	內地 Mainland	1	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly
牛肉 Beef	內地 Mainland	1	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly
豬肝 Pig's liver	內地 Mainland, 本地 Local	2	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly
豬肉 Pork	內地 Mainland, 本地 Local	2	伽馬 γ , 氫 H-3, 銨-90 Sr-90	每季 quarterly

表 1. (續)
Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
土壤(上層及下層) Land soil (upper and lower level)	京士柏* King's Park*, 沙田* Shatin*, 西貢* Sai Kung*, 清水灣* Clear Water Bay*, 萬宜水庫西* High Island West*, 萬宜水庫東* High Island East*, 北潭凹* Pak Tam Au*, 白沙澳* Pak Sha O*, 大埔 Tai Po, 粉嶺 Fanling, 沙頭角 Sha Tau Kok, 大美督 Tai Mei Tuk, 城門水塘 Shing Mun Reservoir, 荃灣 Tsuen Wan, 大欖涌水塘 Tai Lam Chung Reservoir, 青山發電廠 Castle Peak Power Station 元朗 Yuen Long, 尖鼻咀 Tsim Bei Tsui, 石崗 Shek Kong, 嘉道理農場 Kadoorie Farm and Botanic Garden, 長洲 Cheung Chau, 南丫島 Lamma Island, 坪洲 Peng Chau, 銀礦灣 Silvermine Bay 東涌 Tung Chung, 石壁水塘 Shek Pik Reservoir, 大澳 Tai O, 白泥 Pak Nai, 塔門 Tap Mun, 吉澳 Kat O, 平洲 Ping Chau, 跑馬地 Happy Valley 薄扶林水塘 Pokfulam Reservoir, 香港仔下水塘 Lower Aberdeen Reservoir, 深水灣 Deep Water Bay, 大潭水塘 Tai Tam Reservoir, 鶴咀 Cape D'Aguilar, 牛頭角配水庫 Ngau Tau Kok Service Reservoir, 石梨貝水塘 Shek Lei Pui Reservoir	39	伽馬 γ , 銻-90 Sr-90, 鈾-239 Pu-239	每一地點每 5 年採樣一次 Each location is sampled once every 5 years. * 2010 年採樣地點 * locations sampled in 2010

表 1. (續)

Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
水體樣本 Aquatic Samples				
飲用水(經處理) Drinking water (treated)	九龍配水管 Kowloon distribution tap, 屯門配水管 Tuen Mun distribution tap, 沙田濾水廠 Shatin Treatment Works, 屯門濾水廠 Tuen Mun Treatment Works, 油柑頭濾水廠 Yau Kom Tau Treatment Works	5	伽馬 γ , 氫 H-3	每季 quarterly
飲用水(未經處理) Drinking water (untreated)	萬宜水庫 High Island Reservoir, 船灣淡水湖 Plover Cove Reservoir, 木湖 B 抽水站 Muk Wu B Pumping Station, 沙田濾水廠 Shatin Treatment Works, 屯門濾水廠 Tuen Mun Treatment Works, 油柑頭濾水廠 Yau Kom Tau Treatment Works	6	伽馬 γ , 氫 H-3	每季 quarterly
樽裝水(蒸餾水) Bottled water (Distilled)	本地 Local	1	伽馬 γ , 氫 H-3	每季 quarterly
樽裝水(礦泉水) Bottled water (Mineral)	本地 Local	1	伽馬 γ , 氫 H-3	每季 quarterly
地下水 Underground water	長康邨 Cheung Hong Estate, 鈞樂新村 Kwan Lok San Tsuen, 環翠邨 Wan Tsui Estate, 華富邨 Wah Fu Estate, 富山邨 Fu Shan Estate, 清涼法苑 Ching Leung Nunnery	6	伽馬 γ , 氫 H-3	每年 yearly
海水(上層、中層及低層) Sea water (upper, middle and lower level)	橫瀾島 Waglan Island, 火石洲 Basalt Island, 大浪灣 Tai Long Wan, 赤洲 Port Island	4	伽馬 γ , 氫 H-3	每年 yearly
海水中懸浮粒子 (上層、中層及低層) Suspended particulate in sea water (upper, middle and lower level)	橫瀾島 Waglan Island, 火石洲 Basalt Island, 大浪灣 Tai Long Wan, 赤洲 Port Island	4	伽馬 γ , 銻-90 Sr-90, 釷-239 Pu-239	每年 yearly
大魚 <i>Aristichthys nobilis</i> (Big-head carp)	深圳 Shenzhen, 元朗 Yuen Long	2	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
瓜三 <i>Nemipterus japonicus</i> (Melon coat)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
牛鯪 <i>Platycephalus indicus</i> (Bartail flathead)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly

表 1. (續)
Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
水體樣本 Aquatic Samples				
牙帶 <i>Trichiurus haumela</i> (Hair tail)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
三點蟹 <i>Portunus sanguinolentus</i> (Three-spotted crab)	香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	2	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
赤米蝦 <i>Metapenaeopsis barbata</i> (Fire prawn)	香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	2	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
魷魚 <i>Loligo edulis</i> (Squid)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
墨魚 <i>Sepia spp</i> (Cuttlefish)	香港水域 Hong Kong Waters	1	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
蜆 <i>Tapes philippinarum</i> (Clam)	長洲 Cheung Chau, 吐露港 Tolo Harbour	2	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
青口 <i>Perna viridis</i> (Green-lipped mussel)	長洲 Cheung Chau, 吐露港 Tolo Harbour, 大亞灣 Daya Bay	3	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
東風螺 <i>Babylonia formosae</i> (Gastropod)	香港水域 Hong Kong Waters	1	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	每季 quarterly
石莖 <i>Ulva lactuca</i> (Sea lettuce)	布袋澳 Po Toi O	1	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	冬季及春季 winter and spring
漚苔 <i>Enteromorpha prolifera</i> (Sea hair)	吐露港 Tolo Harbour	1	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	冬季 winter
長紫菜 <i>Porphyra dentata</i> (Red algae)	蒲台島 Po Toi Island	1	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	冬季 winter
半葉馬尾藻 <i>Sargassum hemiphyllum</i> (Brown algae)	布袋澳 Po Toi O	1	伽馬 γ , 氫 H-3, 銻-90 Sr-90, 釷-239 Pu-239	冬季及春季 winter and spring
潮間帶土(上層及下層) Intertidal sediment (upper and lower level)	白沙灣 Pak Sha Wan, 尖鼻咀 Tsim Bei Tsui, 沙頭角 Sha Tau Kok	3	伽馬 γ , 釷-239 Pu-239	每季 quarterly
海床沉澱物 Seabed sediment	大灘海 Tai Tan Hoi, 龍蝦灣 Lung Ha Wan, 索罟灣 Picnic Bay, 西區碇泊處 Western Anchorage	4	伽馬 γ , 釷-239 Pu-239	每年 yearly

表 2. 食物樣本概要

Table 2. Summary of food samples

類別 Type	地點 Location	收集樣本總數 Total no. of sample collected
食米 Rice	內地(珠江三角洲) Mainland (Pearl River Delta)	4
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen	4
	沙頭角 Sha Tau Kok	4
菜心 Choi sum	內地(深圳) Mainland (Shenzhen)	4
	本地 Local	4
白菜 Pak choi	內地(深圳) Mainland (Shenzhen)	4
	本地 Local	4
香蕉 Banana	內地(廣東) Mainland (Guangdong)	4
荔枝 Lychee	內地 Mainland	1
柑橘 Mandarin	內地(廣東) Mainland (Guangdong)	2
甘蔗 Sugar cane	內地(廣東) Mainland (Guangdong)	1
雞 Chicken	內地(深圳) Mainland (Shenzhen)	4
	本地 Local	4
鴨 Duck	內地(深圳) Mainland (Shenzhen)	4
牛肉 Beef	內地 Mainland	4
豬肝 Pig's Liver	內地(廣東) Mainland (Guangdong)	4
	本地 Local	4
豬肉 Pork	內地(廣東) Mainland (Guangdong)	4
	本地 Local	4
大魚 <i>Aristichthys nobilis</i> (Big-head carp)	深圳 Shenzhen	3
	元朗 Yuen Long	3
瓜三 <i>Nemipterus japonicus</i> (Melon coat)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
牛鯪 <i>Platycephalus indicus</i> (Bartail flathead)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
牙帶 <i>Trichiurus haumela</i> (Hair tail)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
三點蟹 <i>Portunus sanguinolentus</i> (Three-spotted crab)	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	2

表 2. (續)

Table 2. (cont'd)

類別 Type	地點 Location	收集樣本總數 Total no. of sample collected
赤米蝦 <i>Metapenaeopsis barbata</i> (Fire prawn)	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
魷魚 <i>Loligo edulis</i> (Squid)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
墨魚 <i>Sepia spp</i> (Cuttlefish)	香港水域 Hong Kong Waters	3
蜆 <i>Tapes philippinarum</i> (Clam)	長洲 Cheung Chau	1
	吐露港 Tolo Harbour	3
青口 <i>Perna viridis</i> (Green-lipped mussel)	長洲 Cheung Chau	2
	吐露港 Tolo Harbour	3
	大亞灣 Daya Bay	2
東風螺 <i>Babylonia formosae</i> (Gastropod)	香港水域 Hong Kong Waters	3
石莖 <i>Ulva lactuca</i> (Sea lettuce)	布袋澳 Po Toi O	2
澱苔 <i>Enteromorpha prolifera</i> (Sea hair)	吐露港 Tolo Harbour	1
長紫菜 <i>Porphyra dentata</i> (Red algae)	蒲台島 Po Toi Island	0
半葉馬尾藻 <i>Sargassum hemiphyllum</i> (Brown algae)	布袋澳 Po Toi O	2

表 3. 主要量度參數概要 *

Table 3. Summary of key measurement parameters *

測量類別 Measurement type		樣本大小 Sample size	計數 時間(秒) Counting time (second)	本底 Background (CPM)	計數 效率 Counting efficiency (%)	化學 復得率 Chemical recovery (%)	探測下限 # Minimum Detection Activity # (MDA)	
伽馬放射性 核素 Gamma emitting radionuclides	大氣飄塵 Airborne particulate	20000 m ³	55000	-	-	-	碘-131 I-131 10 µBq m ⁻³	銻-137 Cs-137 10 µBq m ⁻³
	氣態碘 Airborne radioiodine	400 m ³	55000	-	-	-	300 µBq m ⁻³	-
	濕沉積物 Wet deposition	4 L	55000	-	-	-	0.1 Bq L ⁻¹	0.1 Bq L ⁻¹
	總沉積物 Total deposition	0.03 m ²	55000	-	-	-	12 Bq m ⁻²	15 Bq m ⁻²
	食米 Rice	4 kg	20000	-	-	-	0.1 Bq kg ⁻¹	0.2 Bq kg ⁻¹
	牛奶 Milk	1 L	55000	-	-	-	0.2 Bq L ⁻¹	0.3 Bq L ⁻¹
	蔬菜 Vegetable	1 kg	20000	-	-	-	0.3 Bq kg ⁻¹	0.4 Bq kg ⁻¹
	水果 Fruit	2 kg	20000	-	-	-	0.2 Bq kg ⁻¹	0.3 Bq kg ⁻¹
	家禽 Poultry	2 kg	20000	-	-	-	0.1 Bq kg ⁻¹	0.2 Bq kg ⁻¹
	肉類 Meat	1 kg	20000	-	-	-	0.3 Bq kg ⁻¹	0.4 Bq kg ⁻¹
	土壤 Land soil	1 kg	20000	-	-	-	1.0 Bq kg ⁻¹	1.5 Bq kg ⁻¹
	水樣本 Water samples	4 L	55000	-	-	-	0.1 Bq L ⁻¹	0.1 Bq L ⁻¹
	海水中懸浮粒 子 Suspended particulate	4 L	55000	-	-	-	0.01 Bq L ⁻¹	0.02 Bq L ⁻¹
	海產 Seafood	2 kg	72000	-	-	-	0.07 Bq kg ⁻¹	0.1 Bq kg ⁻¹
	海藻 Seaweed	0.5 kg	20000	-	-	-	1 Bq kg ⁻¹	2 Bq kg ⁻¹
潮間帶土/ 海床沉澱物 Sediment	2 kg	20000	-	-	-	0.4 Bq kg ⁻¹	0.5 Bq kg ⁻¹	
氚 Tritium	濕沉積物 Wet deposition	0.007 L	18000	2	25	-	4 Bq L ⁻¹	
	總沉積物 Total deposition	0.0001 m ²	18000	2	25	-	300 Bq m ⁻²	
	水蒸氣 Water vapour	0.05 m ³	36000	4	15	-	1 Bq m ⁻³	
	食米 Rice	0.07 kg	18000	2	25	-	0.5 Bq kg ⁻¹	
	牛奶 Milk	0.007 L	18000	2	25	-	4 Bq L ⁻¹	
	蔬菜 Vegetable	0.008 kg	18000	2	25	-	3 Bq kg ⁻¹	
	水果 Fruit	0.01 kg	18000	2	25	-	3 Bq kg ⁻¹	
	家禽 Poultry	0.01 kg	18000	2	25	-	3 Bq kg ⁻¹	
	肉類 Meat	0.01 kg	18000	2	25	-	3 Bq kg ⁻¹	
	水樣本 Water samples	0.007 L	18000	2	25	-	4 Bq L ⁻¹	
	地下水 Underground water	0.1 L	18000	2	25	-	0.5 Bq L ⁻¹	
	海產 Seafood	0.01 kg	18000	2	25	-	3 Bq kg ⁻¹	
海藻 Seaweed	0.02 kg	18000	2	25	-	1 Bq kg ⁻¹		

表 3. (續)

Table 3. (cont'd)

測量類別 Measurement type		樣本大小 Sample size	計數 時間(秒) Counting time (second)	本底 Background (CPM)	計數 效率 Counting efficiency (%)	化學 復得率 Chemical recovery (%)	探測下限 # Minimum Detection Activity # (MDA)
銻-90 Strontium-90	大氣飄塵 Airborne particulate	5000 m ³	30000	1	75	90	1 μ Bq m ⁻³
	濕沉積物 Wet deposition	2 L	30000	1	75	100	0.002 Bq L ⁻¹
	總沉積物 Total deposition	0.01 m ²	30000	1	75	100	0.5 Bq m ⁻²
	米 Rice	3 kg	30000	1	75	90	0.002 Bq kg ⁻¹
	牛奶 Milk	1 L	30000	1	75	90	0.005 Bq L ⁻¹
	蔬菜 Vegetable	1 kg	30000	1	75	90	0.005 Bq kg ⁻¹
	水果 Fruit	2 kg	30000	1	75	90	0.003 Bq kg ⁻¹
	家禽 Poultry	2 kg	30000	1	75	90	0.003 Bq kg ⁻¹
	肉類 Meat	1 kg	30000	1	75	90	0.005 Bq kg ⁻¹
	土壤 Land soil	0.005 kg	30000	1	75	90	1 Bq kg ⁻¹
	海水中懸浮粒 子 Suspended particulate	3 L	30000	1	75	90	0.002 Bq L ⁻¹
	海產 Seafood	2 kg	30000	1	75	90	0.003 Bq kg ⁻¹
海藻 Seaweed	0.1 kg	30000	1	75	90	0.05 Bq kg ⁻¹	
鈾-239 Plutonium-239	大氣飄塵 Airborne particulate	5000 m ³	220000	0.003	20	40	0.2 μ Bq m ⁻³
	濕沉積物 Wet deposition	2 L	220000	0.003	20	60	0.0004 Bq L ⁻¹
	總沉積物 Total deposition	0.01 m ²	220000	0.003	20	60	0.07 Bq m ⁻²
	土壤 Land soil	0.003 kg	220000	0.003	20	50	0.3 Bq kg ⁻¹
	海水中懸浮粒 子 Suspended particulate	3 L	220000	0.003	20	50	0.0003 Bq L ⁻¹
	海產 Seafood	0.5 kg	220000	0.003	20	40	0.002 Bq kg ⁻¹
	海藻 Seaweed	0.05 kg	220000	0.003	20	60	0.01 Bq kg ⁻¹
	潮間帶土 / 海床沉澱物 Sediment	0.005 kg	220000	0.003	20	50	0.2 Bq kg ⁻¹

註:

- * - 表內所列是 ERMP 在二零一零年主要量度參數的典型數值，僅供參考之用。視乎實際操作情況，量度參數可能有變化。在特別情況下，部份樣本會使用與上表頗為不同的參數進行量度。
- # - 測量的探測下限是指一個測量系統在該次測量時實際能測量到的最低活度水平。探測下限的數值取決於多個因數，包括個別測量系統的特質、測量方法、樣本的特質及測量的情況，所以探測下限會隨著個別樣本和測量而改變。表內所示的探測下限為在一般測量情況下的典型數值，僅供在理解此報告的結果時作簡易參考之用。

Note:

- * - The values given in the table are typical values of key measurement parameters in the ERMP in 2010. The values may vary in practice, and should thus be used as reference only. Under special circumstances, some samples may be measured under substantially different conditions.
- # - The minimum detection activity (MDA) of a measurement is the lowest activity level that is practically achievable by the counting system for that measurement. MDA values depend on the characteristics of the measurement system, method of measurement, sample characteristics and measurement conditions, and thus vary with individual samples and measurements. The listed MDAs are typical values under "typical" measurement conditions and serve as a quick reference in interpreting results in this report.

表 4. 輻射監測網絡及熱釋光劑量計網絡在二零一零年錄得的環境伽馬劑量率。
單位為 $\mu\text{Gy h}^{-1}$

Table 4. Ambient gamma dose rates recorded by the radiation monitoring network and thermoluminescent dosimeter network in 2010
Dose rate in $\mu\text{Gy h}^{-1}$

輻射監測網絡

Radiation Monitoring Network (RMN)

監測站 Station	年平均值 Annual Average	標準差 Standard Deviation	一分鐘平均值範圍 Range of 1-min Average
吉澳 Kat O	0.102	0.003	0.091 – 0.144
京士柏 King's Park	0.138	0.005	0.122 – 0.221
觀塘 Kwun Tong	0.129	0.002	0.110 – 0.192
平洲 Ping Chau	0.095	0.004	0.081 – 0.205
西灣河 Sai Wan Ho	0.096	0.002	0.086 – 0.169
沙頭角 Sha Tau Kok	0.101	0.002	0.089 – 0.156
大美督 Tai Mei Tuk	0.117	0.004	0.100 – 0.167
塔門 Tap Mun	0.084	0.004	0.071 – 0.146
尖鼻咀 Tsim Bei Tsui	0.130	0.003	0.111 – 0.237
元五墳 Yuen Ng Fan	0.114	0.004	0.097 – 0.247
首五年運作參考數值^{&} Reference Values of First 5 Years of Operation^{&}			0.062 – 0.271

註:

- & - 輻射監測網絡始於一九九二年，首五年運作參考數值為一九九二至一九九六年輻射監測網絡錄得的環境伽馬劑量率的範圍。

Note:

- & - Radiation monitoring network started operation in 1992. Reference values of first 5 years of operation are the range of the ambient gamma dose rates recorded by the radiation monitoring network from 1992 to 1996.

表 4. (續)
Table 4. (cont'd)

熱釋光劑量計網絡

Thermoluminescent Dosimeter (TLD) Network

監測點 Location	年平均值 Annual Average	標準差 [*] Standard Deviation [*]	範圍 Range
鶴咀 Cape D'Aguilar	0.13	0.01	0.12 – 0.14
長洲 Cheung Chau	0.12	0.01	0.10 – 0.13
置富花園 Chi Fu Fa Yuen	0.15	0.01	0.14 – 0.16
清水灣 Clear Water Bay	0.10	0.01	0.10 – 0.11
深水灣 Deep Water Bay	0.13	0.01	0.12 – 0.14
粉嶺 Fanling	0.11	0.01	0.09 – 0.12
跑馬地 Happy Valley	0.09	0.01	0.08 – 0.09
吉澳 Kat O	0.10	0.01	0.09 – 0.11
京士柏 King's Park	0.14	< 0.01	0.14 – 0.15
觀塘 Kwun Tong	0.14	0.01	0.13 – 0.15
平洲 Ping Chau	0.12	0.01	0.11 – 0.13
西貢 Sai Kung	0.12	0.01	0.12 – 0.13
沙頭角 Sha Tau Kok	0.09	0.01	0.08 – 0.10
沙田 Shatin	0.13	0.01	0.12 – 0.13
筲箕灣 Shau Kei Wan	0.14	0.01	0.13 – 0.14
石崗 Shek Kong	0.12	0.01	0.10 – 0.12
石梨貝 Shek Lei Pui	0.21	0.01	0.20 – 0.21
大欖涌 Tai Lam Chung	0.19	0.01	0.18 – 0.21
大美督 Tai Mei Tuk	0.14	0.01	0.13 – 0.14
大埔 Tai Po	0.10	< 0.01	0.09 – 0.11
塔門 Tap Mun	0.09	0.01	0.08 – 0.10
尖鼻咀 Tsim Bei Tsui	0.13	0.01	0.13 – 0.14
荃灣 Tsuen Wan	0.14	0.01	0.14 – 0.15
屯門 Tuen Mun	0.15	0.01	0.14 – 0.16
烏溪沙 Wu Kai Sha	0.14	0.01	0.12 – 0.14
元朗 Yuen Long	0.10	0.01	0.09 – 0.11
元五墳 Yuen Ng Fan	0.12	0.01	0.12 – 0.13
BRMP 參考數值[%] BRMP Reference Values[%]			0.03 – 0.29

註:

* - 數值為 1 σ 標準差。

% - BRMP 參考數值為熱釋光劑量計網絡於 BRMP 期間所錄得的伽馬劑量率的範圍。

Note:

* - The value is 1 σ standard deviation.

% - BRMP reference values are the range of the ambient gamma dose rates recorded by the thermoluminescent dosimeter network during BRMP.

表 5. 平洲自動伽馬譜法系統在二零一零年的輻射測量結果

Table 5. Results of measurement by the Automatic Gamma Spectrometry System at Ping Chau in 2010

	年平均值 * Annual Average *	標準差 Standard Deviation	日平均值範圍 Range of Daily Average	首五年(一九九七至二零零一年)參考範圍* Reference range from first 5 years of operation (1997 to 2001) *
阿爾法粒子 Alpha (Bq m ⁻³)	< 1	N/A &	N/A	1.0 – 5.8
貝他粒子 Beta (Bq m ⁻³)	< 1	N/A	N/A	1.0 – 10.1
碘-131 I-131 (mBq m ⁻³)	< 4	N/A	N/A	< 4
銻-137 Cs-137 (mBq m ⁻³)	< 4	N/A	N/A	< 4
氣態碘-131 Gaseous I-131 (Bq m ⁻³)	< 1	N/A	N/A	< 1

註:

* - 測量結果低於探測下限以 “< xx” 表示，xx 是該類測量的典型探測下限值。

& - 不適用以 N/A 表示。

Note:

* - Results below the minimum detectable activity (MDA) are reported as “< xx” where xx is the typical MDA value for that type of measurement.

& - N/A - not applicable.

表 6. 二零一零年宇宙輻射引致的伽馬劑量率測量結果

(測量地點: 船灣淡水湖)

Table 6. Measurement results of gamma dose rates due to cosmic radiation in 2010 (measurement site: Plover Cove)

測量日期 Date of measurement	平均伽馬劑量率(每小時微戈) Average gamma dose rate (μGy h ⁻¹)
二零一零年三月二十六日 26 Mar 2010	0.030
二零一零年六月二十一日 21 Jun 2010	0.032
二零一零年九月十七日 17 Sep 2010	0.034
二零一零年十二月二十三日 23 Dec 2010	0.039

表 7. 二零一零年食物及環境樣本中之人工伽馬放射性核素的可測量伽馬活度測量結果

Table 7. Measurement results of measurable gamma activities of artificial gamma-emitting radionuclides in food and environmental samples in 2010

放射性核素: 銫-137 Radionuclide: Cs-137

類別 Type	地點 Location	含有可測量活度的 樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
牛鯪 <i>Platycephalus indicus</i> (Bartail flathead)	香港水域 Hong Kong Waters	1	-	0.04	≤ 0.2	Bq kg ⁻¹
牙帶 <i>Trichiurus haumela</i> (Hair tail)	大亞灣 Daya Bay	1	-	0.06	≤ 0.2	Bq kg ⁻¹
	香港以西海域 Seas west of Hong Kong	1	-	0.10		
	香港水域 Hong Kong Waters	1	-	0.05		
土壤(上層) Land soil (upper)	見表 1. Please see Table 1.	4	0.6 – 3.6	2.2	≤ 10.0	Bq kg ⁻¹
土壤(下層) Land soil (lower)	見表 1. Please see Table 1.	4	1.2 – 2.6	2.0	≤ 4.0	Bq kg ⁻¹
潮間帶土(上層) Intertidal sediment (upper)	尖鼻咀 Tsim Bei Tsui	3	0.7 – 0.8	0.7	≤ 2.4	Bq kg ⁻¹
	沙頭角 Sha Tau Kok	2	0.5 – 0.8	0.7		
潮間帶土(下層) Intertidal sediment (lower)	白沙灣 Pak Sha Wan	1	-	0.4	≤ 3.1	Bq kg ⁻¹
	尖鼻咀 Tsim Bei Tsui	3	0.7	0.7		
	沙頭角 Sha Tau Kok	3	0.4 – 0.5	0.5		
海床沉澱物 Seabed sediment	大灘海 Tai Tan Hoi	1	-	0.9	≤ 1.9	Bq kg ⁻¹
	龍蝦灣 Lung Ha Wan	1	-	1.2		
	索罟灣 Picnic Bay	1	-	0.7		
	西區碇泊處 Western Anchorage	1	-	0.4		

註: * - 如有多過一個樣本發現可測量活度，此欄則報告平均值。

- BRMP 測量結果低於探測下限以 “< xx” 表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告為 “≤ xx”，xx 則為測量到的活度最大值。

Note: * - The mean activity is reported if there are more than one samples with measurable activities.

- BRMP results that are below the minimum detectable activity (MDA) are reported as “< xx” where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as “≤ xx” where xx is the maximum measured activity value.

表 8. 二零一零年食物及環境樣本的可測量氚活度測量結果

Table 8. Measurement results of measurable activities of tritium in food and environmental samples in 2010

類別 Type	地點 Location	含有可測量活度的 樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen	2	1.3 – 2.8	2.0	< 6	Bq L ⁻¹
	沙頭角 Sha Tau Kok	2	1.7 – 1.8	1.7		
菜心 Choi sum	內地 Mainland	3	0.2 – 2.7	1.4	≤ 7.4	Bq kg ⁻¹
	本地 Local	3	0.6 – 2.1	1.6		
白菜 Pak choi	內地 Mainland	1	-	1.5	< 6	Bq kg ⁻¹
	本地 Local	3	0.4 – 1.3	1.0		
香蕉 Banana	內地 Mainland	3	0.1 – 1.4	1.0	< 3	Bq kg ⁻¹
荔枝 Lychee	內地 Mainland	1	-	0.4	< 4	Bq kg ⁻¹
柑橘 Mandarin	內地 Mainland	2	0.1 – 0.3	0.2	< 4	Bq kg ⁻¹
甘蔗 Sugar cane	內地 Mainland	1	-	0.6	< 2	Bq kg ⁻¹
雞 Chicken	內地 Mainland	1	-	0.2	≤ 2.2	Bq kg ⁻¹
	本地 Local	3	0.1 – 0.2	0.1		
鴨 Duck	內地 Mainland	1	-	0.6	≤ 3.5	Bq kg ⁻¹
牛肉 Beef	內地 Mainland	1	-	1.2	≤ 5.3	Bq kg ⁻¹
豬肝 Pig's liver	內地 Mainland	3	0.3 – 0.9	0.5	< 4	Bq kg ⁻¹
	本地 Local	2	0.4 – 1.3	0.8		
豬肉 Pork	內地 Mainland	2	0.2 – 0.3	0.2	< 4	Bq kg ⁻¹
	本地 Local	1	-	1.0		
大魚 <i>Aristichthys nobilis</i> (Big-head carp)	深圳 Shenzhen	3	0.1 – 0.4	0.2	< 2	Bq kg ⁻¹
	元朗 Yuen Long	2	0.2 – 0.4	0.3		
瓜三 <i>Nemipterus japonicus</i> (Melon coat)	大亞灣 Daya Bay	1	-	0.1	< 2	Bq kg ⁻¹
	香港水域 Hong Kong Waters	3	0.1 – 0.7	0.5		
	香港以南海域 Seas west of Hong Kong	1	-	0.5		
牛鯪 <i>Platycephalus indicus</i> (Bartail flathead)	大亞灣 Daya Bay	1	-	0.02	< 2	Bq kg ⁻¹
	香港水域 Hong Kong Waters	1	-	0.7		
	香港以南海域 Seas west of Hong Kong	1	-	0.3		
牙帶 <i>Trichiurus haumela</i> (Hair tail)	大亞灣 Daya Bay	1	-	0.4	< 2	Bq kg ⁻¹
	香港水域 Hong Kong Waters	2	0.4 – 1.3	0.9		
	香港以南海域 Seas west of Hong Kong	1	-	0.4		

Table 8. (cont'd)

類別 Type	地點 Location	含有可測量活度的 樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
三點蟹 <i>Portunus sanguinolentus</i> (Three-spotted crab)	香港以西海域 Seas west of Hong Kong	1	-	0.2	< 2	Bq kg ⁻¹
赤米蝦 <i>Metapenaeopsis barbata</i> (Fire prawn)	香港以西海域 Seas west of Hong Kong	1	-	0.3	≤ 4.9	Bq kg ⁻¹
墨魚 <i>Sepia</i> spp (Cuttlefish)	香港水域 Hong Kong Waters	3	0.2 – 1.6	0.8	≤ 2.7 @	Bq kg ⁻¹
魷魚 <i>Loligo edulis</i> (Squid)	大亞灣 Daya Bay	1	-	0.9	< 3	Bq kg ⁻¹
	香港水域 Hong Kong Waters	2	1.6 – 1.9	1.8		
	香港以西海域 Seas west of Hong Kong	1	-	1.0		
東風螺 <i>Babylonia formosae</i> (Gastropod)	香港水域 Hong Kong Waters	1	-	0.04	< 1	Bq kg ⁻¹
青口 <i>Perna viridis</i> (Green-lipped mussel)	吐露港 Tolo Harbour	2	0.2 – 0.5	0.4	< 2	Bq kg ⁻¹
	大亞灣 Daya Bay	2	0.3 – 0.7	0.5		
蜆 <i>Tapes philippinarum</i> (Clam)	長洲 Cheung Chau	1	-	0.4	< 2	Bq kg ⁻¹
	吐露港 Tolo Harbour	1	-	0.6		
半葉馬尾藻 <i>Sargassum Hemiphyllum</i> (Brown algae)	布袋澳 Po Toi O	2	0.04 – 0.20	0.12	< 2	Bq kg ⁻¹
浒苔 <i>Enteromorpha Prolifera</i> (Sea hair)	吐露港 Tolo Harbour	1	-	1.7	< 5	Bq kg ⁻¹
石莖 <i>Ulva Lactuca</i> (Sea lettuce)	布袋澳 Po Toi O	1	-	0.2	< 2	Bq kg ⁻¹
濕沉積物 (降雨) Wet deposition (precipitation)	京士柏 King's Park	8	0.5 – 4.9	1.9	≤ 12	Bq L ⁻¹
	沙頭角 Sha Tau Kok	7	0.5 – 5.9	2.5		
	元五墳 Yuen Ng Fan	6	0.3 – 4.2	2.0		
總沉積物 Total deposition	京士柏 King's Park	9	5.8 – 828.7	257.5	≤ 2210 ^S	Bq m ²

Table 8. (cont'd)

類別 Type	地點 Location	含有可測量活度的 樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
飲用水(經處理) Drinking water (treated)	九龍配水管 Kowloon distribution tap	1	-	1.3	< 6	Bq L ⁻¹
	屯門配水管 Tuen Mun distribution tap	2	0.6 – 0.9	0.7		
	油柑頭濾水廠 Yau Kom Tau Treatment Works	2	0.7 – 0.9	0.8		
	屯門濾水廠 Tuen Mun Treatment Works	1	-	2.4		
	沙田濾水廠 Shatin Treatment Works	3	1.1 – 2.2	1.4		
飲用水 (未經處理) Drinking water (untreated)	木湖 B 抽水站 Muk Wu B Pumping Station	2	0.3 – 5.3	2.8	< 6	Bq L ⁻¹
	油柑頭濾水廠 Yau Kom Tau Treatment Works	1	-	1.4		
	屯門濾水廠 Tuen Mun Treatment Works	2	0.5 – 1.1	0.8		
	萬宜水庫 High Island Reservoir	2	0.9 – 1.2	1.1		
	船灣淡水湖 Plover Cove Reservoir	3	0.2 – 5.7	2.2		

Table 8. (cont'd)

類別 Type	地點 Location	含有可測量活度的 樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍# BRMP range #	單位 Unit
地下水 Underground water	長康邨 Cheung Hong Estate	1	-	0.3	≤ 2.8	Bq L ⁻¹
	鈞樂新村 Kwan Lok San Tsuen	1	-	0.2		
	環翠邨 Wan Tsui Estate	1	-	0.2		
	華富邨 Wah Fu Estate	1	-	0.3		
	富山邨 Fu Shan Estate	1	-	0.4		
	清涼法苑 Ching Leung Nunnery	1	-	0.3		
海水(中層) Sea water (middle level)	火石洲 Basalt Island	1	-	0.1	< 6	Bq L ⁻¹
海水(低層) Sea water (lower level)	大浪灣 Tai Long Wan	1	-	0.4	< 6	Bq L ⁻¹
樽裝水(礦泉水) Bottled water (Mineral)	本地 Local	4	0.1 – 1.2	0.6	≤ 5.8 ^{&}	Bq L ⁻¹

- 註: * - 如有多過一個樣本發現可測量活度，此欄則報告平均值。
- BRMP 測量結果低於探測下限以“< xx”表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告為“≤ xx”，xx 則為測量到的活度最大值。
@ - 該樣本沒有在 BRMP 測量。這裡顯示的測量範圍為該樣本首五年(一九九七年至二零零二年)的測量數值。
\$ - 該樣本沒有在 BRMP 測量。這裡顯示的測量範圍為該樣本首五年(一九九六年至二零零零年)的測量數值。
& - 該樣本測量始於二零零七年，並沒有在 BRMP 測量。這裡顯示的測量範圍包含二零零七至二零零九年的樣本測量數值。

- Note: * - The mean activity is reported if there are more than one samples with measurable activities.
- BRMP results that are below the minimum detectable activity (MDA) are reported as “< xx” where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as “≤ xx” where xx is the maximum measured activity value.
@ - The sample was not measured in BRMP. The indicated range refers to results from first 5 years’ sample measurement (1997 to 2002).
\$ - The sample was not measured in BRMP. The indicated range refers to results from first 5 years’ sample measurement (1996 to 2000).
& - Measurement of this sample started in 2007. The sample was not measured in BRMP. The indicated range refers to results from 2007 to 2009 sample measurement.

表 9. 二零一零年食物及環境樣本的可測量銻-90 活度測量結果
Table 9. Measurement results of measurable activities of strontium-90
in food and environmental samples in 2010

類別 Type	地點 Location	含有可測量活度的 樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
食米 Rice	內地 Mainland	4	3 – 5	4	≤ 56	mBq kg ⁻¹
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen	4	8 – 10	9	8 – 81	mBq L ⁻¹
	沙頭角 Sha Tau Kok	4	6 – 41	18		
菜心 Choi sum	內地 Mainland	4	62 – 118	93	≤ 266	mBq kg ⁻¹
	本地 Local	4	17 – 121	80		
白菜 Pak choi	內地 Mainland	4	10 – 63	31	≤ 570	mBq kg ⁻¹
	本地 Local	4	9 – 71	31		
柑橘 Mandarin	內地 Mainland	2	12 – 18	15	10 – 84	mBq kg ⁻¹
雞 Chicken	內地 Mainland	1	-	3	≤ 37	mBq kg ⁻¹
牛肉 Beef	內地 Mainland	2	5	5	≤ 35	mBq kg ⁻¹
豬肉 Pork	內地 Mainland	1	-	9	≤ 36	mBq kg ⁻¹
豬肝 Pig's liver	本地 Local	1	-	9	≤ 43	mBq kg ⁻¹
大魚 <i>Aristichthys nobilis</i> (Big-head carp)	深圳 Shenzhen	2	2 – 3	3	≤ 94	mBq kg ⁻¹
	元朗 Yuen Long	2	3 – 8	5		
魷魚 <i>Loligo edulis</i> (Squid)	大亞灣 Daya Bay	1	-	26	≤ 43	mBq kg ⁻¹
	香港水域 Hong Kong Waters	2	6 – 15	11		
	香港以西海域 Seas west of Hong Kong	1	-	13		
東風螺 <i>Babylonia formosae</i> (Gastropod)	香港水域 Hong Kong Waters	1	-	16	≤ 31	mBq kg ⁻¹
青口 <i>Perna viridis</i> (Green-lipped mussel)	長洲 Cheung Chau	2	5 – 22	13	≤ 47	mBq kg ⁻¹
	吐露港 Tolo Harbour	1	-	33		
	大亞灣 Daya Bay	1	-	11		
蜆 <i>Tapes philippinarum</i> (Clam)	長洲 Cheung Chau	1	-	13	≤ 32	mBq kg ⁻¹
	吐露港 Tolo Harbour	2	6 – 26	16		

表 9. (續)
Table 9. (cont'd)

類別 Type	地點 Location	含有可測量活度的 樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
大氣飄塵 Airborne particulate	沙頭角 Sha Tau Kok	5	1.2 – 3.4	1.8	≤ 5	μBq m ⁻³
	元五墳 Yuen Ng Fan	3	0.9 – 2.7	1.9		
濕沉積物(降雨) Wet deposition (precipitation)	京士柏 King's Park	1	-	3.2	≤ 39	mBq L ⁻¹
	沙頭角 Sha Tau Kok	2	17.4 – 24.6	21.0		
	元五墳 Yuen Ng Fan	3	4.4 – 26.2	13.0		
總沉積物 Total deposition	京士柏 King's Park	2	0.2 – 3.1	1.7	≤ 3.9 [§]	Bq m ⁻²
土壤(上層) Land soil (upper)	見表 1. Please see Table 1.	9	2.1 – 25.6	9.5	≤ 27.3	Bq kg ⁻¹
土壤(下層) Land soil (lower)	見表 1. Please see Table 1.	9	1.3 – 19.4	8.7	≤ 19.9	Bq kg ⁻¹

註: * - 如有多過一個樣本發現可測量活度，此欄則報告平均值。
- BRMP 測量結果低於探測下限以“< xx”表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告為“≤ xx”，xx 則為測量到的活度最大值。
§ - 該樣本沒有在 BRMP 測量。這裡顯示的測量範圍為該樣本首五年(一九九六年至二零零零年)的測量數值。

Note: * - The mean activity is reported if there are more than one samples with measurable activities.
- BRMP results that are below the minimum detectable activity (MDA) are reported as “< xx” where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as “≤ xx” where xx is the maximum measured activity value.
§ - The sample was not measured in BRMP. The indicated range refers to results from first 5 years' measurement (1996 to 2000).

表 10. 二零一零年食物及環境樣本的可測量鈾-239活度測量結果

Table 10. Measurement results of measurable activities of plutonium-239 in food and environmental samples in 2010

類別 Type	地點 Location	含有可測量活度的 樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
潮間帶土(上層) Intertidal sediment (upper)	尖鼻咀 Tsim Bei Tsui	1	-	0.17	≤ 0.19	Bq kg ⁻¹
海床沉澱物 Seabed sediment	索罟灣 Picnic Bay	1	-	0.37	≤ 0.57	Bq kg ⁻¹
	西區碇泊處 Western Anchorage	1	-	0.37		
	大灘海 Tai Tan Hoi	1	-	0.34		
	龍蝦灣 Lung Ha Wan	1	-	0.37		

註:

- * - 如有多過一個樣本發現可測量活度，此欄則報告平均值。
- # - BRMP 測量結果低於探測下限以“< xx”表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告為“≤ xx”，xx 則為測量到的活度最大值。

Note:

- * - The mean activity is reported if there are more than one samples with measurable activities.
- # - BRMP results that are below the minimum detectable activity (MDA) are reported as “< xx” where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as “≤ xx” where xx is the maximum measured activity value.

表 11. 二零一零年整體測量結果概要

Table 11. Overall summary of measurement results in 2010

途徑 Pathway	樣本類別 Sample Type	測量結果/ 參考數值 [#] Mea. results / ref. values ^{*,#}	碘-131 I-131	銫-137 Cs-137	氚 H-3	銣-90 Sr-90	鈾-239 Pu-239	單位Unit
大氣 Atmospheric	大氣飄塵 Airborne Particulate	範圍 % Range % BRMP	< 10 ≤ 328	< 10 < 10	--- ^s	0.9 – 3.4 ≤ 5	< 0.2 < 0.2	μBq m ⁻³
地面 Terrestrial	食米 Rice	範圍 Range BRMP	< 0.1 < 0.1	< 0.2 ≤ 0.9	< 0.5 < 1	0.003 – 0.005 ≤ 0.056	---	Bq kg ⁻¹
	牛奶 Milk	範圍 Range BRMP	< 0.2 < 0.2	< 0.3 ≤ 0.3	1.3 – 2.8 < 6	0.006 – 0.041 0.008 – 0.081	---	Bq L ⁻¹
	蔬菜 Vegetable	範圍 Range BRMP	< 0.3 < 0.3	< 0.4 < 0.4	0.2 – 2.7 ≤ 7.4	0.009 – 0.121 ≤ 0.570	---	Bq kg ⁻¹
水 Aquatic	魚Fish	範圍 Range BRMP	< 0.07 < 0.1	0.04 – 0.10 ≤ 0.2	0.02 – 1.3 < 2	0.002 – 0.008 ≤ 0.094	< 0.002 < 0.002	Bq kg ⁻¹
	經處理的 飲用水 Treated Drinking Water	範圍 Range BRMP	< 0.1 < 0.1	< 0.1 < 0.1	0.6 – 2.4 < 6	---	---	Bq L ⁻¹

註:

- 測量結果低於探測下限以“< xx”表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告為“≤ xx”，xx 則為測量到的活度最大值。

% - 二零一零年各樣本類別的輻射測量結果範圍以粗體列印。

s - “---”表示沒有在 BRMP 及 ERMP 進行此項測量。

Notes:

* - “mea.” – measurement; “ref.” – reference.

- Results that are below the minimum detectable activity (MDA) are reported as “< xx” where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as “≤ xx” where xx is the maximum measured activity value.

% - The range of measurement results in 2010 for each of the listed sample types is shown in bold.

s - Measurements not included under the BRMP and ERMP are reported as “---” in the table.