



## Could plutonium be a substitute of $^{137}\text{Cs}$ for tracing soil erosion?

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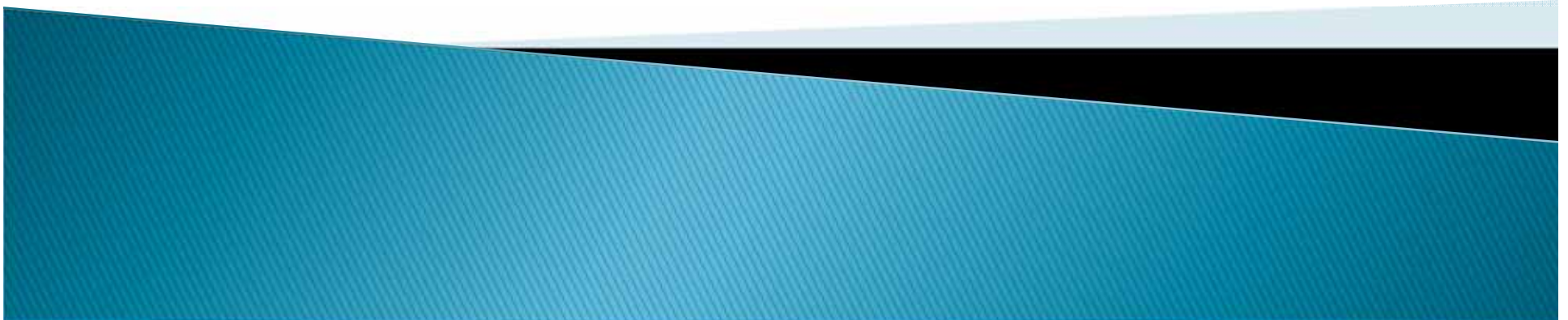
# Could plutonium be a substitute of $^{137}\text{Cs}$ for tracing soil erosion?

Yihong Xu

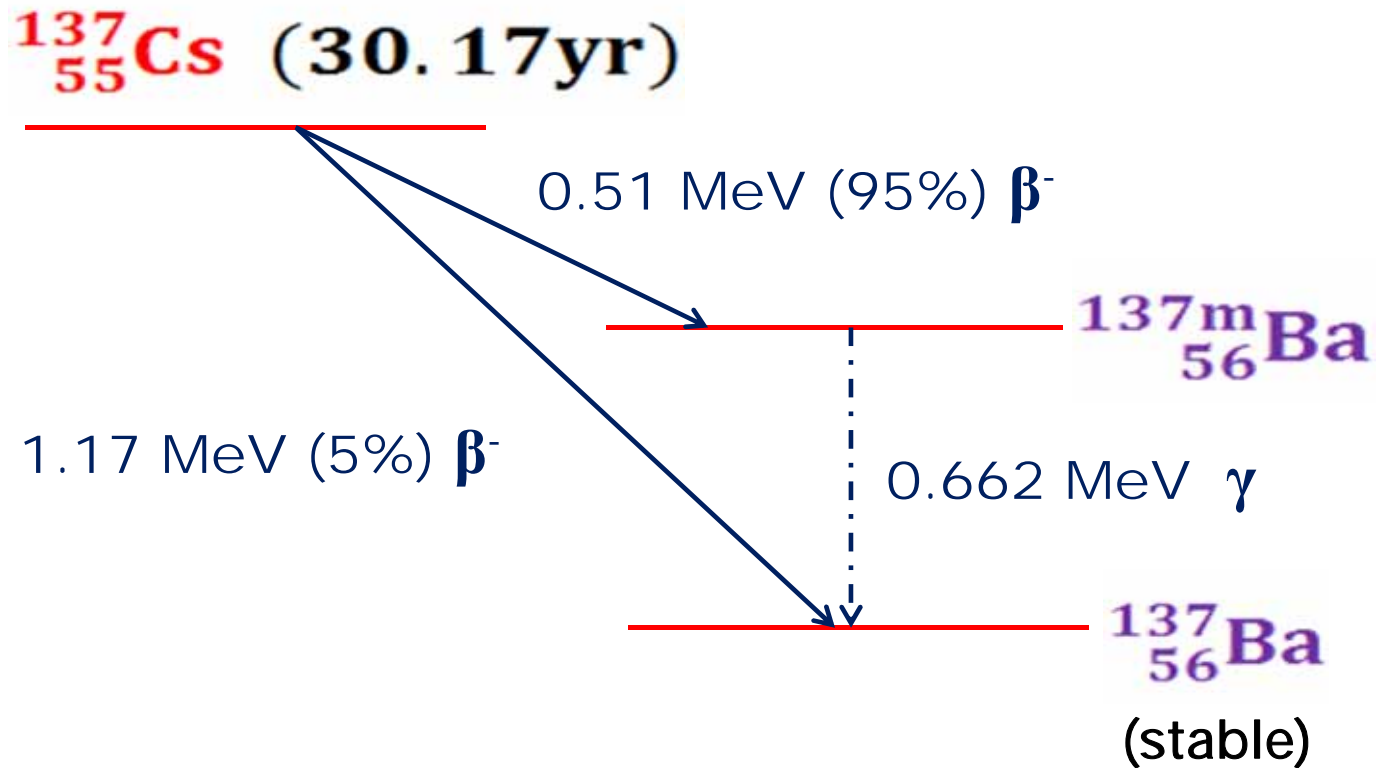
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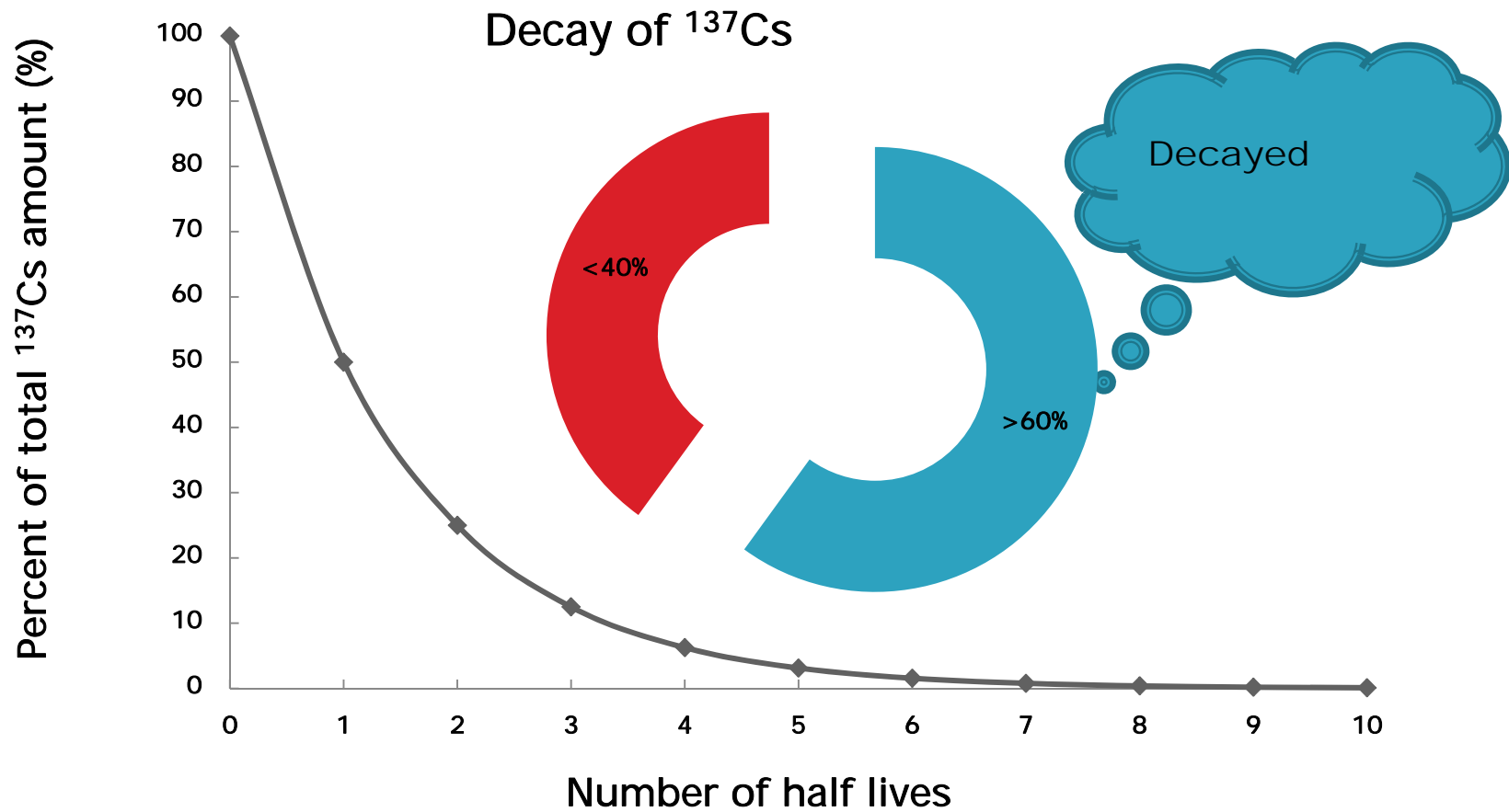
Nanjing University, China

06-09-2013



◆ The most widely used soil erosion tracer--- $^{137}\text{Cs}$





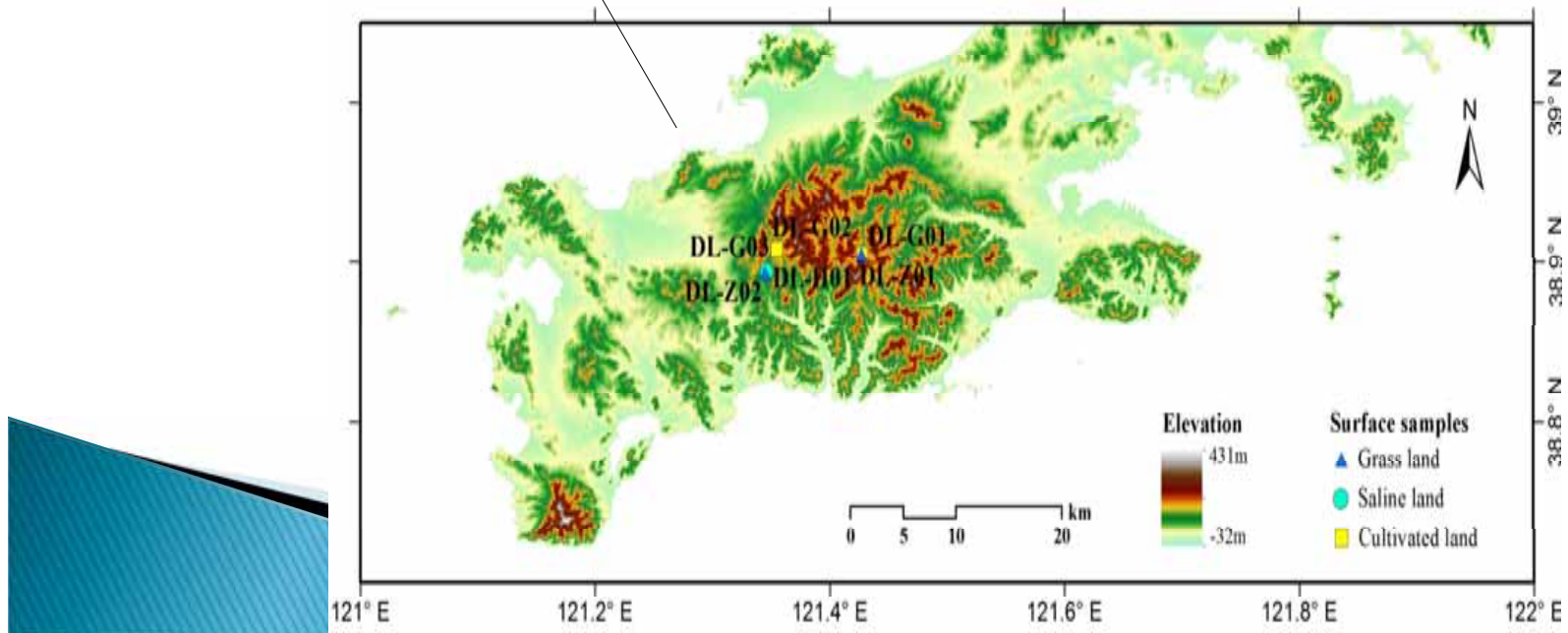
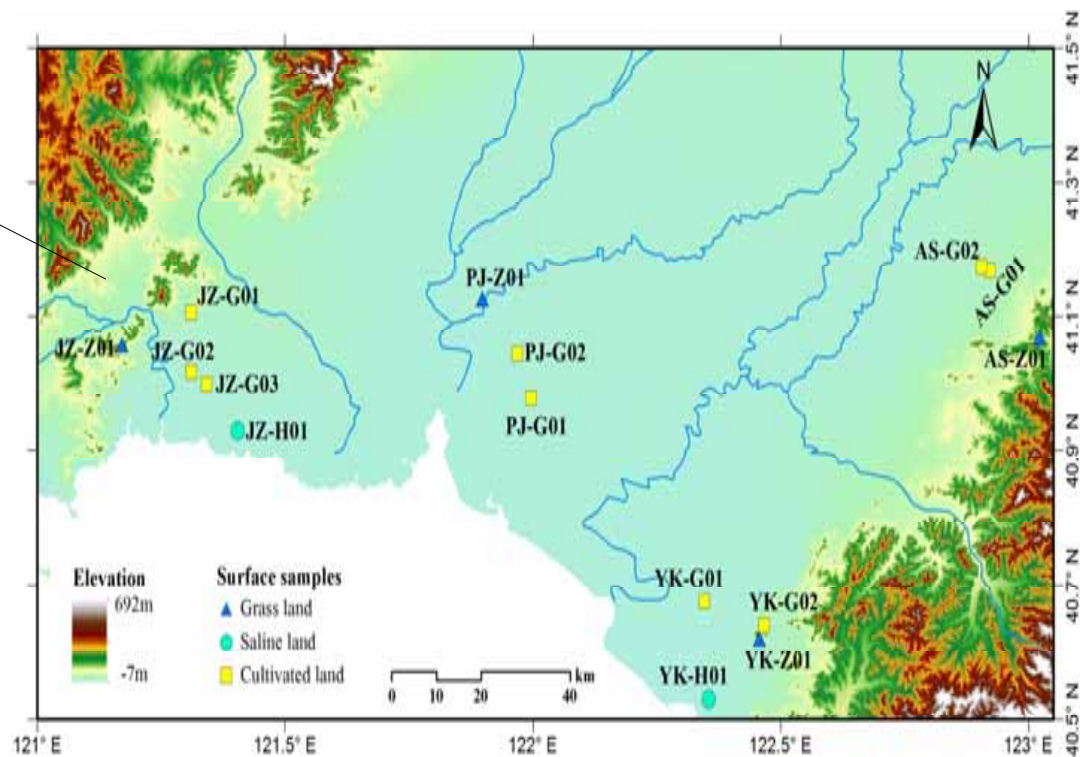
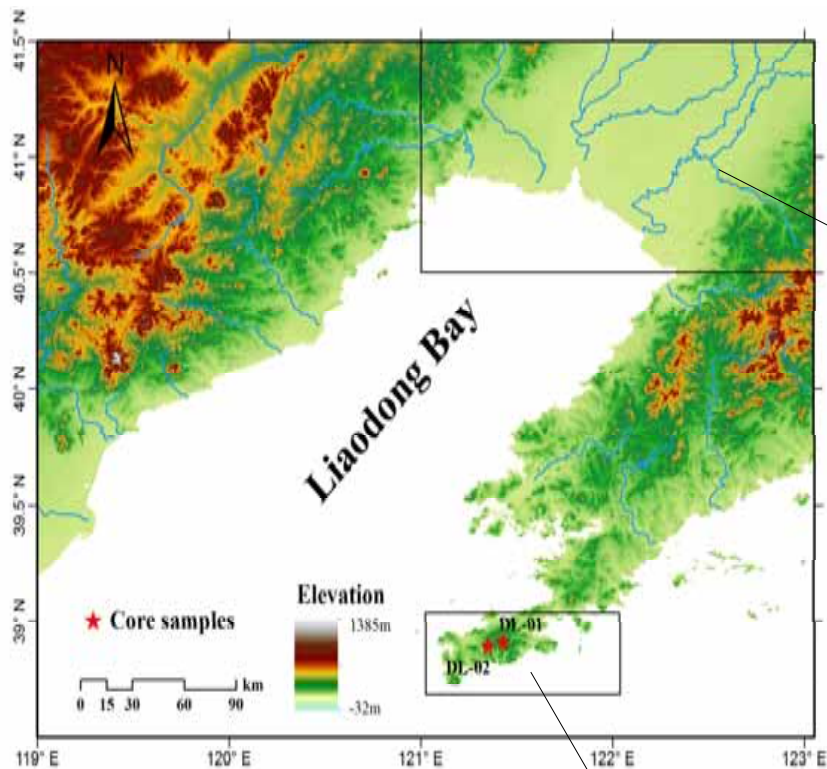
The application of  $^{137}\text{Cs}$  for soil erosion study  
will be difficult in future  
----find a substitute



◆ Pu isotopes ( $^{239}\text{Pu}$  and  $^{240}\text{Pu}$ ) --- potential substitutes of  $^{137}\text{Cs}$  for tracing soil erosion

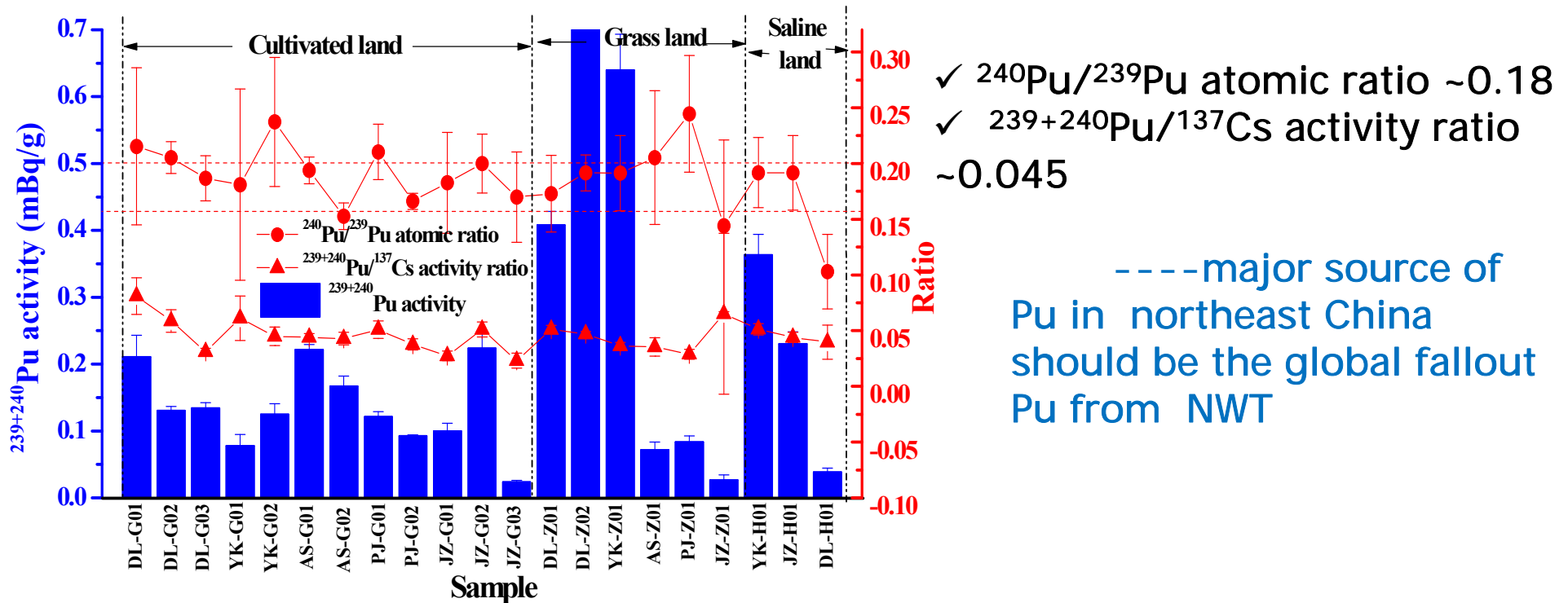
- Same dominating source of global fallout worldwide as  $^{137}\text{Cs}$
- Much longer half-lives ( $^{239}\text{Pu}$  and  $^{240}\text{Pu}$ ) than  $^{137}\text{Cs}$
- High particle affinity and low mobility in soil
- More sensitive detection supported by measurement techniques of mass spectrometry





# ◆ Plutonium in soils collected from northeast China

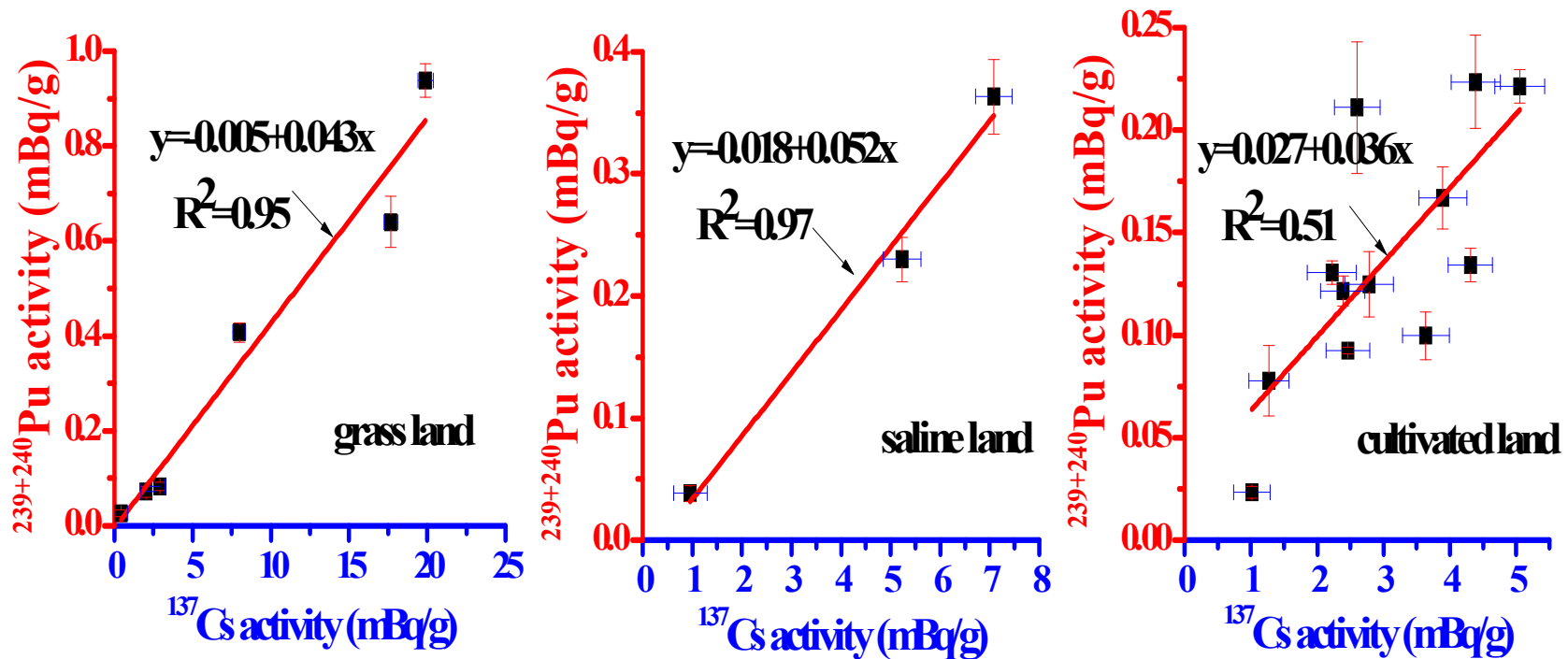
## ➤ Spatial distribution of plutonium in surface soils



✓ Pu conc. in surface soils varying with land types, Pu conc. in grass land were significantly higher than those in cultivated land

---- migration behavior of Pu influenced by land use patterns and human activities

➤ Correlation between the concentration of  $^{239+240}\text{Pu}$  and  $^{137}\text{Cs}$  in surface soils



✓ High correlation between the conc. of Pu and  $^{137}\text{Cs}$  were observed in surface soils, especially in grass land and saline land



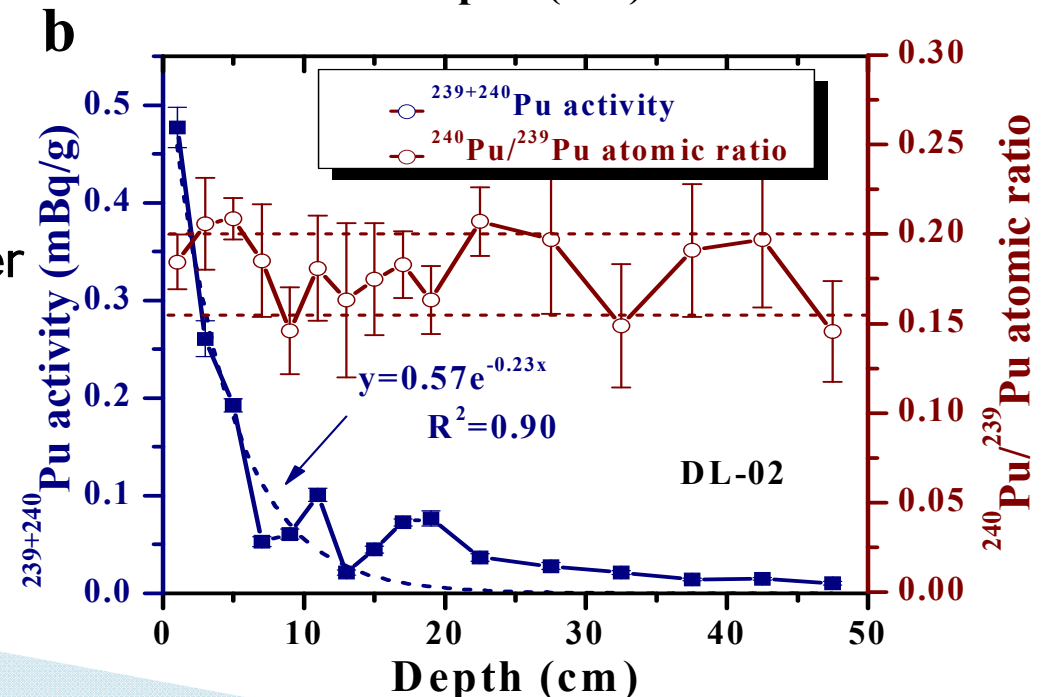
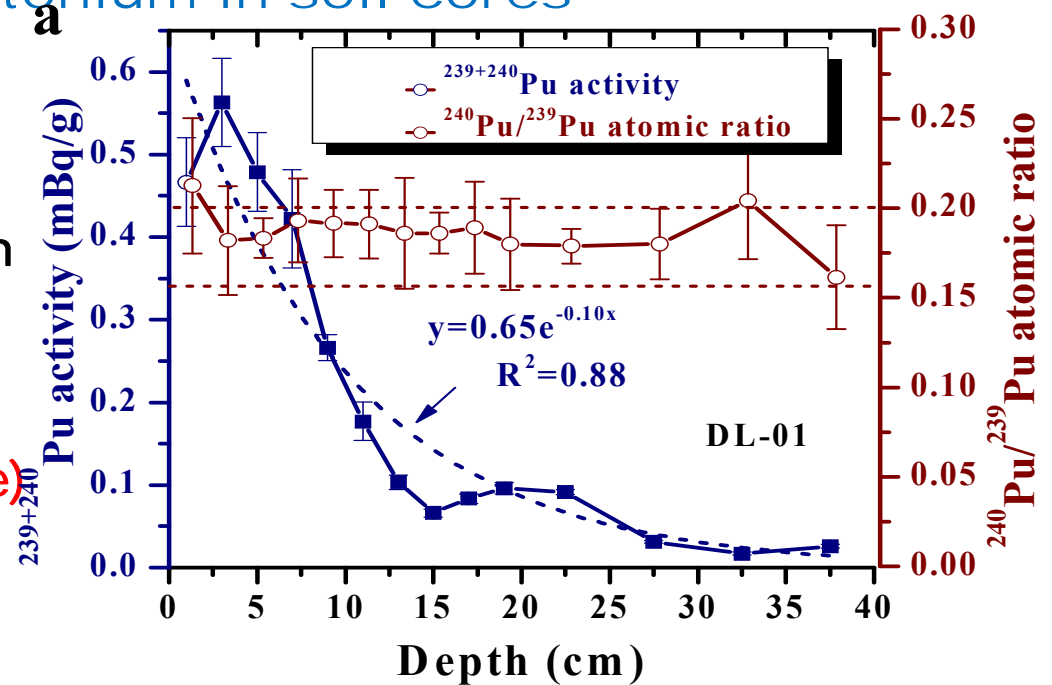
## ➤ Vertical distribution of plutonium in soil cores

✓ The atomic ratio of  $^{240}\text{Pu}/^{239}\text{Pu}$  in two cores  $\sim 0.18$

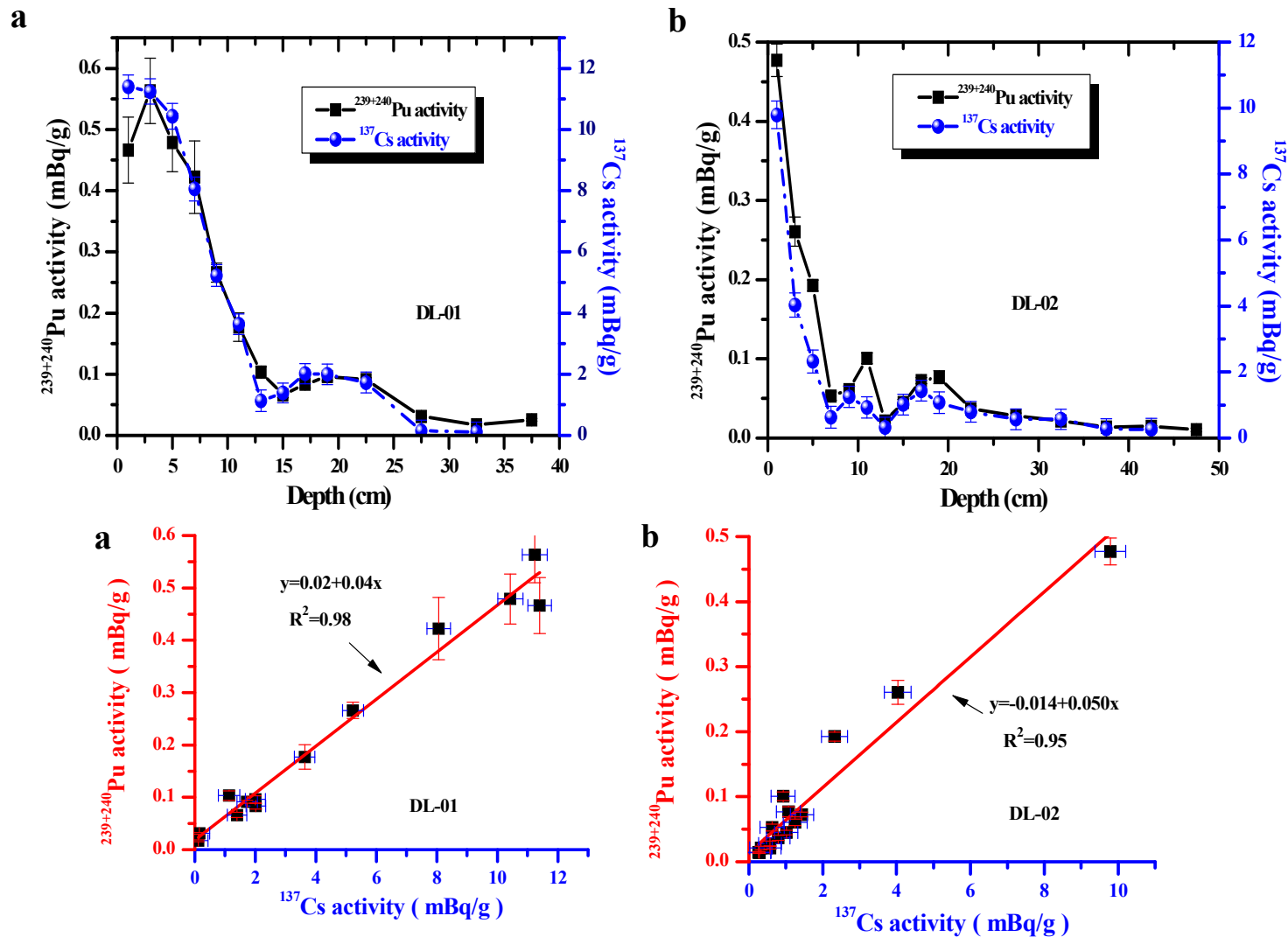
✓ The sub-surface maximum of Pu conc. in DL-01 core (reference core)

✓ Pu concentration exponentially decreased with soil depth in both cores

✓ Small peak values of Pu conc. in deep layers --- roots, organic matter content



➤ Comparison of the profiles of Pu and  $^{137}\text{Cs}$  in each soil core



✓ The physical transport of  $^{239+240}\text{Pu}$  and  $^{137}\text{Cs}$  in soils should be very similar, they could convey similar information about erosion and redistribution of soils in a small area

# ◆ The feasibility of using Pu as soil erosion tracer

Table 1 The inventories of Pu and <sup>137</sup>Cs in soil cores<sup>a</sup>.

Depth (cm)	<sup>239+240</sup> Pu (Bq/m <sup>2</sup> )	<sup>239+240</sup> Pu inventory distribution (%)	<sup>137</sup> Cs <sup>b</sup> (Bq/m <sup>2</sup> )	<sup>137</sup> Cs inventory distribution (%)
<b>DL-01</b>				
(reference core)				
0-6	41.8 ± 2.5	48	916 ± 19	54
6-20	33.6 ± 1.9	39	650 ± 25	38
> 20	11.5 ± 0.3	13	138 ± 40	8
<b>Total</b>	<b>86.9 ± 3.1</b>		<b>1704 ± 40</b>	
<b>DL-02</b>				
(studied core)				
0-6	24.5 ± 0.6	56	426 ± 17	56
6-20	11.3 ± 0.4	26	175 ± 22	23
> 20	8.2 ± 0.4	18	163 ± 46	21
<b>Total</b>	<b>44.1 ± 0.9 (51%)<sup>c</sup></b>		<b>764 ± 47 (45%)<sup>c</sup></b>	

<sup>a</sup> All given uncertainties are one standard deviation.

<sup>b</sup> <sup>137</sup>Cs activities were decay corrected to 1<sup>st</sup> Sept. 2009.

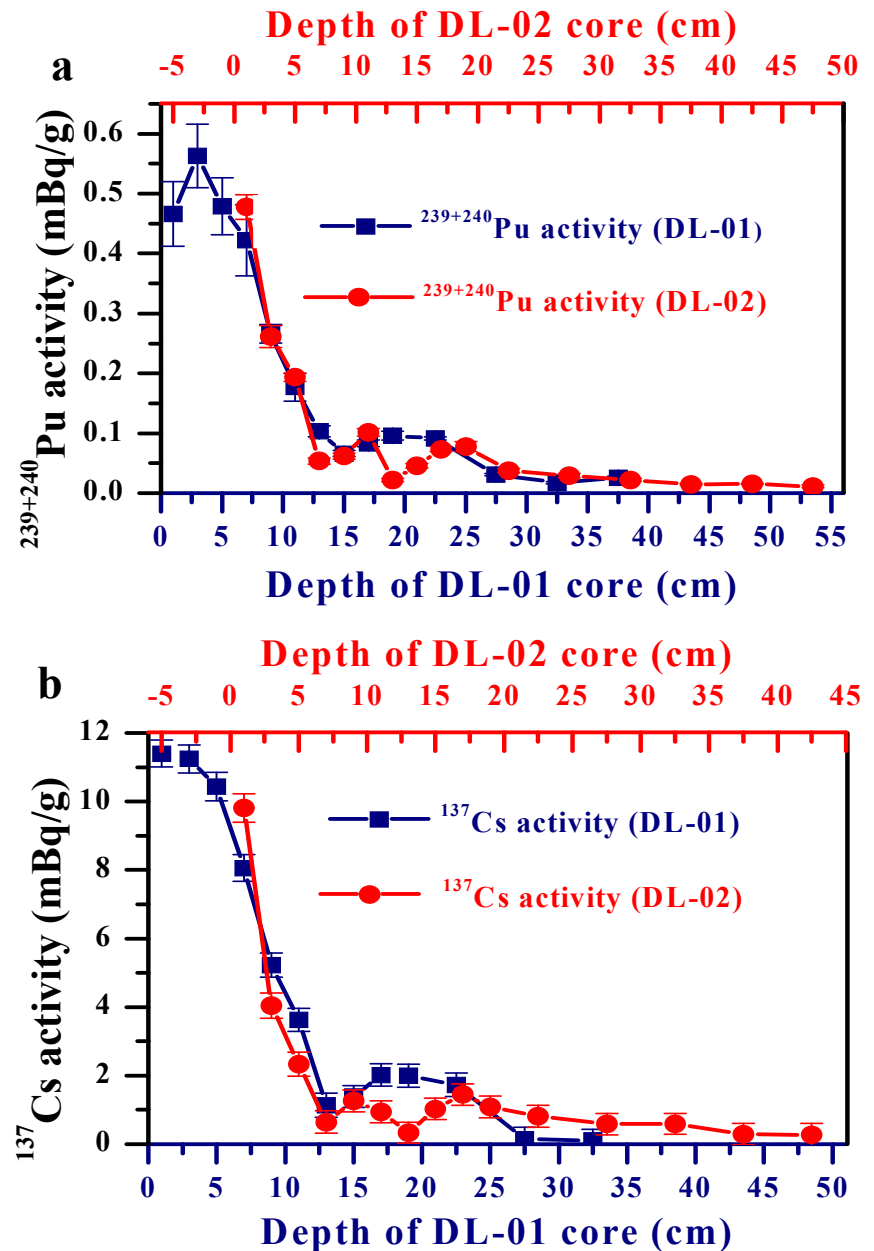
<sup>c</sup> Numbers in parentheses indicate percentages relative to the inventory of the reference core DL-01.

# ◆ The feasibility of using Pu as soil erosion tracer

✓ Comparing the Pu profiles between the two soil cores, deducing that the top ~6 cm soil in the site of DL-02 core might be eroded;

✓ Similar conclusion could also be deduced based on the  $^{137}\text{Cs}$  profiles

----- Pu could be an ideal substitute of relative short-lived fallout  $^{137}\text{Cs}$  for tracing soil erosion and redistribution in the future.



## ◆ Future work

- ✓ To estimate the intensity of the erosion in a specific site of the area, more comprehensive work involving analysis of Pu profiles in a series of soil cores and modeling of downwards migration of Pu has to be carried out.

Thank you for  
your attention!

